THE

Compleat Surveyor:

Or, the WHOLE ART of

SURVEYING

OF

LAND,

BY

A New INSTRUMENT lately invented;

As also by the

Plain Table, Circumferentor, the Theodolite as now improv'd, or by the Chain only.

CONTAINING

Plain and Easy DIRECTIONS in several Kinds of MENSURATIONS, and Other Things necessary to be known in a Work of this Nature.

By *WILLIAM LEYBOURN.*

The WHOLE Altered and Amended, and TWO entire BOOKS added by the AUTHOR long before his DEATH.

The FIFTH EDITION, in IX BOOKS.

Every *Operation* both *Geometrical* & *Arithmetical* being examin'd;

AND AN

APPENDIX

Added to the WHOLE, Consisting of

Practical Observations in Land Surveying,

By SAMUEL CUNN.

LONDON:

Printed for SAMUEL BALLARD at the *Blue Ball*, and AARON WARD at the *King's Arms* in *Little Britain*, and THO. WOODWARD at the *Half-Moon* against *St. Dunstan's* Church in *Fleetstreet*. 1722.

TO THE

READER.

IT is not uncommon for Persons by the Fireside to prescribe Rules, which they would have Surveyors *observe Abroad: And yet if such Persons withdraw to the Field, they often find it impossible to put their Precepts, tho' Geometrically true, in Practice; and themselves as aukward to perform. So necessary, to the well Performance of any thing in the Mathematical Arts, is a former Practice under a good Guide (as well as the Theory); that no Person of sound Judgment will entrust him (either to direct or perform) who is not thus qualified.*

The Author of this Treatise was frequently employed in Surveying, Measuring and Mapping Gentlemens Estates; as evidently appears from the several Draughts by him drawn, and to be met with in almost every County in England.

These Qualifications alone recommended the first Edition; and the Book itself made way for Three more afterwards.

If to these be added, the great Enquiries made for this Book (notwithstanding the many Tracts on this Subject,) and the many Improvements herein contained, which were

not in the former Editions, and indeed moſt of them not before Printed; they may be juſtly accounted ſufficient Reaſons for Publiſhing this fifth Edition. Nevertheleſs, it may not be improper to give the Reader a ſummary Account of the principal Improvements.

The Author, long before his Death, made ſeveral Remarks, not publiſh'd in the former Editions. In the firſt Book, the various Caſes, of which ſome Problems admitted, are in this ſupply'd. In the ſecond Book is an Account of an Inſtrument, by him contrived. In the third Book the Tables of Logarithms, Sines and Tangents are more commodiouſly placed; and a fuller Deſcription and Uſe of the Artificial Lines of Numbers, Sines and Tangents added. In the fourth Book, ſeveral Problems are omitted, becauſe performed with more Expedition and Accuracy, by Methods laid down in the following Books. And ſeveral Problems added relating to caſting up the Contents of Lands, by Methods more conciſe and ready, and more fit for a Practitioner, than any heretofore Publiſh'd. And alſo ſeveral Remarks on the modern Water-Level. The fifth and ſixth Books are entirely new; and contain the Deſcription and Uſe of a new Inſtrument, invented by the Author, and his Method of Surveying by the Chain only, &c. And after the ſeventh, eighth, and ninth Books, which in the fourth Edition, were the fifth, ſixth and ſeventh, there is added an Appendix, by Mr. Cunn, *containing ſeveral practical Obſervations of Matters occurring in his Method of Surveying. A more particular Account, of all which, you have in the Table of Contents.*

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THE

The COMPLEAT SURVEYOR.

The FIRST BOOK.

The *ARGUMENT.*

THIS *first* Book *consisteth of divers* Definitions *and* Problems Geometrical, *extracted out of the Writings of divers Antient and Modern* Geometricians, *as* Euclid, Ramus, Bagdedine, Clavius, *&c. which are here so methodically disposed, that any man may gradually proceed from* Problem *to* Problem *without Interruption, or being referred to any other* Author *for the practical Performance of any of them. Only the*

Demonſtration is wholly omitted; partly, becauſe thoſe Books *out of which they were extracted are very large in that particular; and alſo for the avoiding of many other* Propoſitions *and* Theoremes, *which (had the enſuing* Problems *been* demonſtrated) *muſt of neceſſity have been inſerted. Alſo, the Figures would have been ſo incumbred with multiplicity of Lines, that the intended* Problems *would have been thereby much darkned. And beſides, it was not my Intent, in this place, to make an abſolute or entire* Treatiſe *of* Geometry; *and therefore I have only made choice of ſuch* Problems *as I conceived moſt uſeful for my preſent purpoſe, and come moſt in uſe in the practice of* Surveying. *They are in Number* 40, *and ought of neceſſity to be known by every Man that intendeth to attain to a competent Proficiency in the Practice thereof: And thoſe are chiefly ſuch as concern the reducing of* Plots *from one Form to another, and to enlarge or diminiſh them according to any aſſigned* Proportion. *Alſo divers of the* Problems *in this* Book *will abundantly help the* Surveyor *in the Diviſion and Separation of* Land, *and in the laying out of any aſſigned Quantity, whereby large Parcels may be readily divided into divers ſeverals; and thoſe again ſub-divided, if need be. Alſo, for the better ſatisfaction of the* Reader, *I have performed divers of the following* Problems *as well* Arithmetically *as* Geometrically.

GE-

GEOMETRICAL DEFINITIONS.

1 *A* Point *is that which cannot be divided.*

A *Point* or *Sign* is that which is void of all *Magnitude*, and is the leaſt thing that by Mind and Underſtanding can be imagined and conceived, than which there can be nothing leſs. As the *Point* or *Prick* noted with the Letter A, which is neither Quantity nor Part of Quantity, only the Term or End of Quantity. And herein a *Point* in Geometry differeth from *Unity* in *Number*.

A

2 *A* Line *is a Length, without Breadth or Thickneſs.*

A *Line* is created or made by the moving or drawing out of a *Point* from one place to another: ſo the *Line* A B (*fig.* 1.) is made by moving of a *Point* from A to B: and according as this Motion is, ſo is the *Line* thereby created, whether *Straight* or *Crooked*. And of the Three kinds of *Magnitudes* in *Geometry*, viz. *Length*, *Breadth*, and *Thickneſs*, a *Line* is the firſt, conſiſting of *Length* only

only; and therefore the *Line* A B is capable of diviſion in *Length* only, and may be Divided equally in the *Point* C, or unequally in D, and the like, but will admit of no other Dimenſion.

3 *The Ends or Bounds of a* Line *are* Points.

This is to be underſtood of a Finite *Line* only, as is the Line A B (*fig.* 1) the Ends or Bounds whereof are the Points A and B: But in a Circular *Line* it is otherwiſe, for there the *Point* in its motion returneth again to the Place where it firſt began, and ſo maketh the *Line* infinite, and the Ends or Bounds thereof undeterminate.

4 *A* Right Line *is that which lieth equally between his Points.*

As the *Right Line* A C D B (*fig.* 1) lieth ſtraight and equal between the Points A and B (which are the Bounds thereof) without bowing, and is the ſhorteſt of all other Lines that can be drawn between thoſe Two Points.

5 *A* Superficies *is that which hath only Length and Breadth.*

As the motion of a Point produceth a Line, the firſt kind of Magnitude; ſo the motion of a Line produceth a *Superficies*, which is the ſecond kind of Magnitude; and is capable of two Dimenſions, namely, Length and Breadth: and ſo the *Superficies* A B C D (*fig.* 2) may be divided in length from A to B, and alſo in breadth from A to C.

6 *The Extreams of a* Superficies *are Lines.*

As the Extreams or Ends of a Line are Points, ſo the Extreams or Bounds of a *Superficies* are Lines; and ſo the Extreams or Ends of the *Superficies* A B C D, (*fig.* 2) are the Lines A B, B D, D C, and C A, which are the Terms or Limits thereof.

7 *A Plain* Superficies *is that which lieth equally between his Lines.*

So the *Superficies* A B C D lieth direct and equally between his Lines: and whatſoever is ſaid of a *Right Line*, the ſame is alſo to be underſtood of a *Plain Superficies.*

8. *A plain right-lined* Angle *is the Inclination or Bowing of two right Lines, the one to the other, the one touching the other, and not being directly joined together.*

As the two right Lines A B and B C (*fig.* 3.) incline the one to the other, and touch one another in the Point B, in which Point, by reaſon of the inclination of the ſaid Lines, is made the *Angle* A B C. But if the two Lines which touch each other be without Inclination, and be drawn directly one to the other, then they make no Angle at all; as the Lines C D and D E touch each other in the point D, and yet they make no Angle, but one continued right Line.

¶ And here note, that an Angle commonly is ſigned by three Letters, the middlemoſt whereof ſheweth the angular Point: As in this Figure, when we ſay the Angle A B C, you are to underſtand the very Point at B, the Quantity of which Angle is meaſured by an Arch of a Circle deſcribed upon the angular Point B. And note alſo, that the Length of the Sides containing any Angle, as the Sides A B and B C do not make the Angle A B C either greater or leſſer; but the Angle ſtill retaineth the ſame Quantity, be the containing Sides thereof either longer or ſhorter.

9. *When a right Line ſtanding upon a right Line maketh the Angles on either Side equal, then either of thoſe* Angles *is a* right Angle; *and the right Line which ſtandeth erected, is called a* Perpendicular Line *to that whereon it ſtandeth.*

As upon the right Line C D, (*fig.* 4.) ſuppoſe there do ſtand another right Line A B, in ſuch ſort that it maketh the Angles on either Side thereof equal, namely, the Angle A B D on the one Side, equal to the Angle A B C on the other Side; then are either of the two Angles A B C and A B D right Angles, and the right Line A B, which ſtandeth erected upon the right Line C D, without inclining to either Part thereof, is a Perpendicular to the Line C D.

10. *An* obtuſe Angle *is that which is greater than a right Angle.*

So the Angle CBE (*fig.* 5.) is an obtuſe Angle, becauſe it is greater than the Angle ABC, which is a right Angle; for it doth not only contain that right Angle, but the Angle ABE alſo, and therefore is obtuſe.

11. *An* acute Angle *is leſs than a right Angle.*

So the Angle EBD (*fig.* 5.) is an acute Angle, for it is leſs than the right Angle ABD (in which it is contained) by the other acute Angle ABE.

12. *A* Limit *or* Term *is the end of every thing.*

As a *Point* is the Limit or Term of a *Line*, ſo a *Line* likewiſe is the Limit and Term of a *Superficies*, and a *Superficies* is the Limit and Term of a *Body*.

13. *A* Figure *is that which is contained under one Limit or Term, or many.* Vid. Fig. 6.

As the Figure A is contained under one Limit or Term; alſo the Figure B is contained under three right Lines, which are the Limits or Terms thereof. Likewiſe the Figure C is contained under four right Lines, the Figure D under five right Lines, and ſo of all other Figures.

¶ And here note, that in the following Work we call any plain Superficies, whoſe Sides are unequal (as the Figure E) a *Plot*, or *Plat*, as of a Field, Wood, Park, Foreſt, and the like.

14. *A*

14. *A* Circle *is a plain Figure contained under one Line, which is called a* Circumference, *unto which all Lines drawn from one Point within the Figure, and falling upon the Circumference thereof, are equal one to the other.* Vid. Fig. 7.

As the Figure BCDE is a Circle contained under the crooked Line BCDE, which Line is called the Circumference or Peripherie, In the middle of this Figure is a Point A, from which Point all Lines drawn to the Circumference thereof are equal, as the Lines AB, AC, AF, AD; and this Point A is called the Center of the Circle.

15. *A* Diameter *of a Circle is a right Line drawn by the Center thereof, and ending at the Circumference on either side; dividding the Circle into two equal Parts.* Vid. Fig. 7.

So the Line BAD in the former Figure is the Diameter thereof, becauſe it paſſeth from the Point B on the one ſide of the Circumference, to the Point D on the other ſide of the Circumference, and paſſeth alſo by the Point A, which is the Center of the Circle. And moreover, it divideth the Circle into two equal Parts, namely, BCD being on one ſide of the Diameter, equal to BED on the other ſide of the Diameter. And this Obſervation was firſt made by *Thales Mileſius*; for, ſaith he, *If a Line drawn by the Center of any Circle do not divide it equally, all the Lines drawn from the Center of that Circle to the Circumference cannot be equal.*

16. *A* Semicircle *is a Figure contained under the Diameter, and that Part of the Circumference cut off by the Diameter.* Vid. Fig. 7.

As in the former Circle the Figure BED is a Semicircle, becauſe it is contained under the right Line BAD, which is the Diameter, and the crooked Line BED being that Part of the Circumference which is cut off by the Diameter; alſo the Figure BCD is a Semicircle.

17. *A*

17. *A* Quadrant *is the fourth Part of any Circle, and is contained under two right Lines drawn from the Center of the Circle, and one fourth Part of the Circumference of the same Circle.* Fig. 7.

18. *A* Segment *of a Circle is a Figure contained under a right Line, and a Part of a Circumference greater or less than a Semicircle.* Fig. 7.

So in the former Circle, the Figure B A C is a Quadrant, for that it is contained under the two right Lines A B and A C, and the crooked (or arch) Line B H C, which is one fourth Part of the Circumference B C D E.

So in the former Figure B C D G E, G B F which is contained under the Part of the Circumference G B F, and the right Line G F is a Segment of a Circle greater than a Semicircle.

Also the other Figure G D F, which is contained under the right Line G F, and the Part of the Circumference G D F is a Segment of a Circle less than a Semicircle.

¶ And here note. That a *Segment* is such a Part as is either greater or lesser than a Semicircle; so that a Semicircle cannot properly be called a *Segment* of a Circle.

19. *Right-lined Figures are such as are contained under right Lines.*

Three-sided Figures are such as are contained under three right Lines.

Four-sided Figures are such as are contained under four right Lines.

Many-sided Figures are such as have more Sides than four.

20. *All three-sided Figures are called* Triangles.

And such are the Triangles A, B, C. *Fig.* 8.

21. *Of*

21. *Of four-sided Figures*; *a* Quadrat, *or* Square, *is that whose Sides are equal, and its Angles right*: As the Figure A. Vid. Fig. 9.

22. *A* Long Square *is that which hath right Angles, but unequal Sides*: As the Figure B. Vid. Fig. 10.

23. *All other Figures of four unequal Sides and Angles are called* Trapezias.

Such are all Figures of four Sides, in which is obſerved no equality of Sides or Angles, as the Figures A and B, which have neither equal Sides nor equal Angles. *Vid. Fig.* 11, 12.

24. Parallel *or* Equidiſtant *right Lines are ſuch, which being drawn in one and the ſame Superficies, and produced infinitely on both Sides, will never in any part concur or meet.*

As the right Lines A B and C D (*fig.* 17) are parallel one to the other, if they were infinitely extended on either Side, would never meet or concur together, but ſtill retain the ſame Diſtance.

Geometrical Theoremes.

1. *ANY two right Lines crossing one another, make the contrary or vertical Angles equal.* Euclid. 15. 1.

2. *If any right Line fall upon two parallel right Lines, it maketh the outward Angles on the one equal to the inward Angles on the other, and the two inward opposite Angles on contrary Sides of the falling Line also equal.* Euclid. 29. 1.

3. *If any Side of a Triangle be produced, the outward Angle is equal to the two inward opposite Angles, and all the three Angles of any Triangle are equal to two right Angles.* Euclid. 32. 1.

4. *In equiangled Triangles, all their Sides are proportional, as well such as contain the equal Angles, as also the subtendent Sides.*

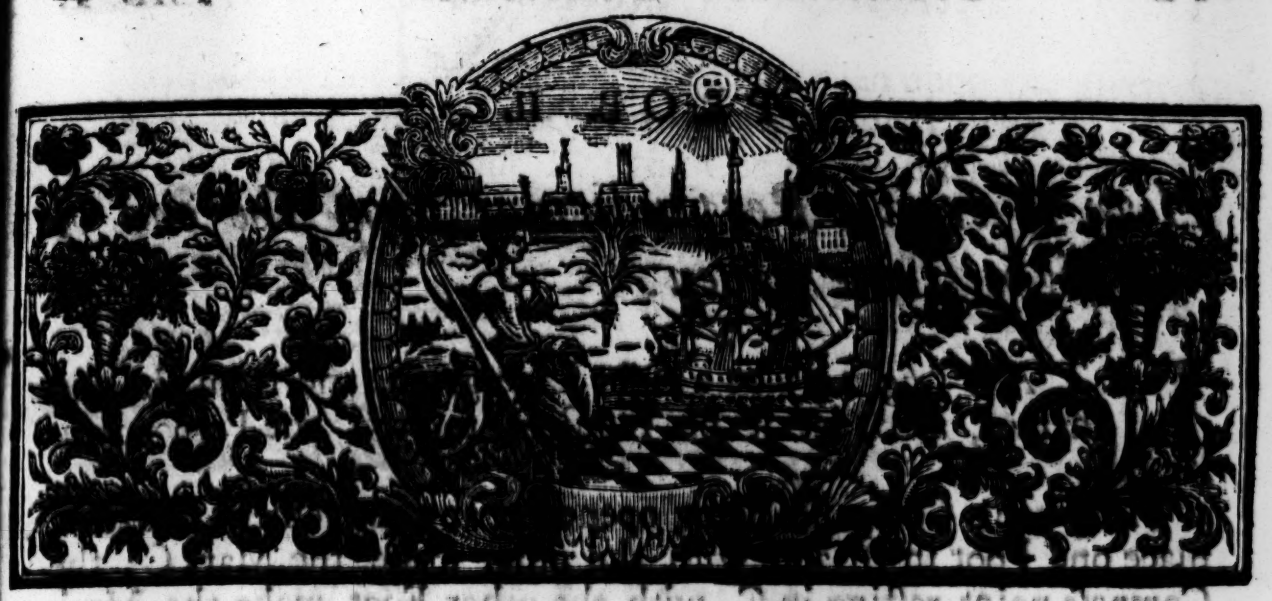
5. *If any four Quantities be proportional, the first multiplied in the fourth, produceth a quantity equal to that which is made by Multiplication of the second in the third.*

6. *In all right-angled Triangles, the Square of the Side subtending the right Angle is equal to both the Squares of the containing Sides.* Euclid. 47. 1.

7. *All Parallelograms are double to the Triangles that are described upon their Bases, their Altitudes being equal.* Euclid. 41. 1.

8. *All Triangles that have one and the same Base, and lye between two parallel Lines, are equal one to the other.* Euclid. 37. 1.

Geo-



GEOMETRICAL PROBLEMS.

PROBLEM I.

Upon a right Line given, how to erect another right Line, which shall be perpendicular to the right Line given.

THE right Line given is AB (*fig.* 13) upon which from the Point E it is required to erect the perpendicular EH.

Opening your Compasses at pleasure to any convenient distance, place one foot in the assigned Point E, and with the other make the Marks C and D, equidistant on each side the given Point E. Then opening your Compasses again to any other convenient Distance, wider than the former, place one Foot in C, and with the other describe the Arch GG; also (the Compasses remaining at the same Distance) place one Foot in the Point D, and with the other describe the Arch FF: Then from the Point where these two Arches intersect or cut each other (which is at H) draw the right Line HE, which shall be perpendicular to the given right Line AB, which was the thing required to be done.

PROB.

PROB. II.

How to erect a Perpendicular upon the end of a right Line given.

LET A B (*fig.* 14.) be a right Line given, and from the end thereof, at B, let it be required to erect the Perpendicular B F.

First, your Compasses being opened at any convenient Distance, place one Foot in B, and with the other make the Mark C; the Compass point resting in C, with the other Foot make the Mark D, in the given Line A B; and then lay a Ruler from D to C, and draw the Line D E, making C E equal to C D. Lastly, from B, through E, draw the Line B F, which shall be perpendicular to the given Line A B.

PROB. III.

How to let fall a Perpendicular from any Point assigned, upon a right Line given.

THE Point given (*fig.* 15.) is C, from which Point it is required to draw a right Line, which shall be perpendicular to the given right Line A B.

First, from the given Point C, to the Line A B, draw a Line by Chance, as C E, which divide into two equal Parts in the Point D: then placing one Foot of the Compasses on the Point D, with the Distance D C, describe the Semicircle C F E, cutting the given Line A B in the Point F. Lastly, if from the Point C you draw the right Line C F, it shall be a Perpendicular to the given Line A B, which was required.

PROB. IV.

How to make an Angle equal to an Angle given.

LET the Angle given be A C B (*fig.* 16.) and let it be required to make another Angle equal thereunto.

First,

First, draw the Line E F at pleasure; then upon the given Angle at C, (the Compasses opened to any Distance) describe the Ark A B; also upon the Point F, (the Compasses unaltered) describe the Ark D E; then take with your Compasses the Distance A B, and set the same Distance from E to D. Lastly, draw the Line D F, so shall the Angle D F E be equal to the given Angle A C B.

PROB. V.

A right Line being given, how to draw another right Line which shall be parallel to the former, at any Distance required.

THE Line given is A B (*fig.* 17.) unto which it is required to draw another right Line parallel thereunto, at the Distance M N.

First, Open your Compasses to the Distance M N, then placing one Foot in A, with the other describe the Ark C; also place one Foot in B, and with the other describe the Ark D. Lastly, draw the Line C D, so that it may only touch the Arks C and D; so shall the Line C D be parallel to the Line A B, and at the Distance M N, as was required.

PROB. VI.

A right Line being given, how to draw another right Line parallel thereunto, which shall also pass through a Point assigned.

LET A B (*fig.* 18.) be a Line given, and let it be required to draw another Line parallel thereunto, which shall pass through the given Point C.

First, take with your Compasses the Distance from A to C, and placing one Foot thereof in B, with the other describe the Ark D E; then take in your Compasses the whole Line A B, and placing one Foot in the Point C, with the other describe the Ark F G, crossing the former Ark D E in the Point H. Lastly, if you draw the Line C H. it shall be parallel to A B.

PROB. VII.

To divide a right Line given into any Number of equal Parts.

LET AB (*fig.* 19.) be a right Line given, and let it be required to divide the ſame into four equal Parts.

Firſt, from the end of the given Line A, draw the Line A C, making any Angle; then from the other end of the given Line, which is at the Point B, draw the Line B D parallel to A C, (or make the Angle A B D equal to the Angle C A B;) then upon the Lines A C and B D, ſet off any three equal Parts (which is one leſs than the Number of Parts into which the Line is to be divided) on each Line, as 1, 2, 3; then draw Lines from 1 to 3, from 2 to 2, and from 3 to 1, which Lines, croſſing the given Line A B, ſhall divide it into four equal Parts as was required.

PROB. VIII.

Any three right Lines being given, ſo that the two ſhorteſt together be longer than the third, to make thereof a Triangle.

LET it be required to make a Triangle of the three Lines A, B, and C, (*fig.* 20.) the two ſhorteſt whereof, *viz.* A and B together, are longer than the third Line C.

Firſt, draw the Line D E equal to the given Line B, then take with your Compaſſes the Line C, and ſetting one Foot in E, with the other deſcribe the Arch H G; alſo take the given Line A in your Compaſſes, and placing one Foot in D, with the other deſcribe the Arch K F, cutting the former Arch H G in the Point O. Laſtly, if from the Point O, you draw the Lines O E and O D, you ſhall conſtitute the Triangle O D E, whoſe Sides ſhall be equal to the three given Lines A, B, C.

In like manner a Triangle l m n may be made equal to L M N, another given. *See Fig.* 21.

Alſo any rectilineal Figure a b c d e f g, equal to any other rectilineal Figure A B C D E F G, by making the Triangles a b g, b g f, b f e, b c e, c e d, reſpectively equal to the Triangles A B G, B G F, B F E, B C E, C E D. *See Fig.* 22.

PROB.

PROB. IX.

Having a right Line given, how to make a Geometrical Square, whoſe Side ſhall be equal to the right Line given.

THE Line given is Q R (*fig.* 23.) and it is required to make a Geometrical Square, whoſe Side ſhall be equal to the Line Q R.

Firſt, draw the Line A B, making it equal to the given Line Q R; then (*by the firſt or ſecond Problem*) upon the Point B, raiſe the Perpendicular B C, making the Line B C equal to the given Line Q R alſo; then taking the Line Q R in your Compaſſes, place one Foot in C, and with the other deſcribe the Arch D E; alſo the Compaſſes ſo reſting, place one Foot in A, and with the other deſcribe another Arch F G, croſſing the former in the Point H. Laſtly, draw the Lines H C, and H A, which ſhall include the Geometrical Square A B C H.

PROB. X.

Two right Lines being given, how to find a third right Line, which ſhall be in proportion unto them.

LET the two given Lines be A and B, (*fig.* 24.) and let it be required to find a third Line, which ſhall be in proportion unto them.

Firſt, draw two right Lines, making any Angle at pleaſure, as the Lines O P, and O N, making the Angle P O N; then taking the Line A in your Compaſſes, ſet the Length thereof from O to S; alſo, take the Line B in your Compaſſes, and ſet the Length thereof from O to R, and alſo from O to D; then draw the right Line S D, and from the Point R draw the right Line R C parallel to S D; ſo ſhall O C be the third Proportional required. For,

As O S to O D; ſo is O R to O C.
8 12 12 18.

PROB.

PROB. XI.

Three right Lines being given, to find a fourth in Proportion to them.

THE three Lines given are A B C, (*fig.* 25.) unto which it is required to find a fourth proportional Line. *This is to perform the Golden Rule, or Rule of Three in Lines.*

As in the laſt Problem, you muſt draw two Lines making any Angle, as the Angle D E F; then take the Line A in your Compaſſes, and ſet it from E to G; then take the Line B in your Compaſſes, and ſet that Length from E to H; then take the third given Line in your Compaſſes, and ſet that from E to K, and through that Point K draw the Line K L, parallel to G H, ſo ſhall the Line E L be the third Proportional required. For,

As E G to E H : : ſo E K to E L.
24 28 36 42

¶ Here note, That in the Performance of this Problem, the firſt and the third Terms (namely, the Lines A and C) muſt be ſet upon the ſame Line, as here upon the Line E D, and the ſecond Term (namely, the Line B) muſt be ſet upon the other Line E F, upon which Line alſo the fourth Proportional E L will be found.

PROB. XII.

To divide a right Line given into two Parts, which ſhall have ſuch Proportion one to the other as two given right Lines.

THE Line given is A B, (*fig.* 26.) and it is required to divide the ſame into two Parts, which ſhall have the ſame Proportion one to the other, as the Line C hath to the Line D.

Firſt, from the Point A draw the Line A [illegible], making the Angle E A B; then take in your Compaſſes the Line C, and ſet it from A to F; alſo take the Line D, and ſet it from F to B, and draw the Line E B; then from the Point F draw the Line F G parallel to E B, cutting the given Line A B in the Point G; ſo is the

the Line A B divided into two Parts in the Point G, being in Proportion one to the other, as the Line C is to the Line D: For,

As A E to A B: : ſo A F to A G.

Arithmetically.

LET the Line A B contain 40 Perches, and let the Line C be 20, and the Line D 30; and let it be required to divide the Line A B into two Parts, being in Proportion one to the other, as the Line C is to the Line D.

Firſt, add the Lines C and D together, their Sum is 50; then ſay by the Rule of Proportion, If 50 (which is the Sum of two given Terms) give 40, the whole Line A B, what ſhall 30, the greater given Term, give? Multiply and divide, and you ſhall have in the Quotient 24, for the greater Part of the Line A B, which being taken from 40, the whole Line, there remains 16 for the other Part A G. For,

As A E to A B: : ſo F E to G B.
50 40 30 24

PROB. XIII.

How to divide a Triangle *into two Parts, according to any Proportion aſſign'd, by a Line drawn from any Angle thereof, and to lay the leſſer Part towards any Side aſſigned.*

LET A B C (*fig.* 27.) be a Triangle given; and let it be required to divide the ſame by a Line drawn from the Angle A into two Parts, the one bearing Proportion to the other, as the Line F doth to the Line G, and that the leſſer Part may be towards the Side A B.

By the laſt *Problem* divide the Baſe of the Triangle B C, in the Point D, in Proportion as the Line F is to the Line G, the leſſer Part being ſet from B to D). Laſtly, draw the Line A D, which ſhall divide the Triangle A B C in Proportion as F to G. For,

As the Line F is to the Line G;
So is the Triangle A D C to the Triangle A B D.

PROB. XIV.

The Baſe of the Triangle *being known, to perform the foregoing Problem by Arithmetick.*

SUppoſe the Baſe of the Triangle B C, (*fig.* 27.) to be 40, and let the Proportion into which the Triangle A B C is to be divided, be as 2 to 3.

Firſt, add the two proportional Terms together, 2 and 3, which makes 5; then ſay by the Rule of Proportion, If 5 (the Sum of the proportional Terms) give 40, (the whole Baſe B C) what ſhall 3 (the greater Term) give? Multiply and divide, and the Quotient will give you 24 for the greater Segment of the Baſe D C, which being deducted from the whole Baſe 40, there will remain 16 for the leſſer Segment B D.

PROB. XV.

How to divide a Triangle, *whoſe* Area *or Content is known, into two Parts, by a Line drawn from an Angle aſſigned, according to any Proportion required.* Fig. 27.

LET the Triangle A B C contain 8 Acres, and let it be required to divide the ſame into two Parts, by a Line drawn from the Angle A, the one to contain 5 Acres, and the other 3 Acres.

Firſt, meaſure the whole Length of the Baſe, which ſuppoſe 40, then ſay, If 8 Acres (the Quantity of the whole Triangle) give 40, (the whole Baſe) what Parts of the Baſe ſhall 5 Acres give? Multiply and divide, the Quotient will be 25 for the greater Segment of the Baſe C D, which being deducted from 40 (the whole Baſe) there will remain 15 for the leſſer Segment of the Baſe B D: then draw the Line A D, which ſhall divide the Triangle A B C according to the Proportion required.

PROB.

PROB. XVI.

How to divide a Triangle; *given, into two Parts, according to any Proportion aſſigned, by a Line drawn from a Point limited in any of the Sides thereof; and to lay the greater or leſſer Part towards an Angle aſſigned.*

THE Triangle given is A B C, (*fig.* 28.) and it is required, from the Point E, to draw a Line that ſhall divide the Triangle into two Parts, being in Proportion one to the other, as the Line I is to the Line K, and to lay the leſſer Part towards B.

Firſt, from the limited Point E draw a Line to the oppoſite Angle at A; then divide the Baſe B C, in Proportion as I to K, which Point of Diviſion will be at D; then draw D F parallel to A E. Laſtly, from F draw the Line F E, which will divide the Triangle into two Parts, being in Proportion one to the other, as the Line I is to the Line K.

PROB. XVII.

To perform the foregoing Problem Arithmetically.

IT is required to divide the Triangle A B C (*fig.* 28.) from the Point E, into two Parts, in Proportion as 5 to 2.

Firſt, divide the Baſe B C, according to the given Proportion; then (becauſe the leſſer Part is to be laid towards B) meaſure the Diſtance from E to B, which admit 30; then ſay by the Rule of Proportion, If E B 30, give D B 15, what ſhall A B 31, give? Multiply and divide, the Quotient will be 15 ½, which lay from B to F; then from F, draw the Line F E, which ſhall divide the Triangle, according to the required Proportion.

PROB.

PROB. XVIII.

How to divide a Triangle, *whose* Area *or Content is known, into two Parts, by a Line drawn from a Point limited in any Side thereof, according to any number of Acres, Roods, and Perches.*

IN the foregoing Triangle A B C, (*fig.* 28.) whose *Area* or Content is 5 Acres, 1 Rood, let the limited Point be E in the Base thereof, and let it be required from the Point E to draw a right Line, which shall divide the Triangle into two Parts between ♍ and ♎, so that ♍ may have 3 Acres, 3 Roods thereof, and ♎ may have 1 Acre and 2 Roods thereof.

First, reduce the Quantity of ♎ (being the lesser) into Perches, which makes 240; then (considering on which Side of the limited Point E this Part is to be laid, as towards B) measure that part of the Base from E to B 30 Perches, whereof take the half, which is 15, and thereby divide 240, the part belonging to ♎, the Quotient will be 16, the Length of the Perpendicular F H; at which parallel Distance from the Base B C, cut the Side A B in F, from whence draw the Line F E, which shall cut off the Triangle F B E, containing 1 Acre 2 Roods, the part belonging to ♎; then will the Trapezia A F E C (which is the part belonging to ♍, contain the Residue, namely, 3 Acres, 3 Roods.

But of this see more in the laying out of Lands.

PROB. XIX.

How to divide a Triangle, *according to any Proportion given, by a Line drawn parallel to one of the Sides given.*

THE Triangle A B C (*fig.* 29.) is given, and it is required to divide the same into two parts, by a Line drawn parallel to the Side A C, which parts shall be in proportion one to the other, as the Line I is to the Line K.

First, (*by the* 12*th Problem*) divide the Line B C in E, in Proportion as I to K; then (*by the* 24*th Problem following*) find a mean Pro-

proportional between B E and B C, which let B F, from which Point F draw the Line F H parallel to A C, which Line ſhall divide the Triangle into two parts, *viz.* the Trapezia A H F C, and the Triangle H F B, which are in proportion one to the other as the Line K is to the Line I.

PROB. XX.

To perform the foregoing Problem Arithmetically.

LET the Triangle be A B C (*fig.* 29.) and let it be required to divide the ſame into two parts, which ſhall be in proportion one to the other, as 4 to 5, by a Line drawn parallel to one of the Sides.

Firſt, let the Baſe B C containing 54, be divided according to the Proportion given, ſo ſhall the leſſer Segment B E contain 24, and the greater E C 30; then find out a mean proportional Line between B E 24, and the whole Baſe B C 54, by multiplying 54 by 24, whoſe Product will be 1296, the ſquare Root whereof is 36, the mean Proportional ſought, which is B F; then through F draw a Line parallel to A C, and it is the Partition required; or elſe, by the Rule of Proportion ſay, If B C 54, give B F 36, what will A B 39 give? Anſwer, B H 26; therefore draw H F, and it is the Partition required.

PROB. XXI.

To divide a Triangle *of any known Quantity into two parts, by a Line drawn parallel to one of the Sides, according to any number of Acres, Roods, and Perches.*

THE Triangle given is A B C, (*fig.* 29.) whoſe Quantity is 8 Acres, 0 Roods, 16 Perches; and it is required to divide the ſame (by a Line drawn parallel to the Side A C) into two parts, *viz.* 4 Acres, 2 Roods, 0 Perches, and 3 Acres, 1 Rood, 16 Perches.

First, reduce both Quantities into Perches, *as is hereafter taught in the 28th Problem*) and they will be 720 and 576; then reduce both those Numbers, by Abbreviation, into the least proportional Terms, *viz.* 5 and 4; and according to that Proportion, divide the Base B C 54 of the given Triangle in E; then seek the mean Proportion between B E and B C, which Proportional is B F 36, of which 36 take the half, and thereby divide 576, the lesser Quantity of Perches, the Quotient will be H G 32, at which parallel Distance from the Base, cut off the Line A B in H, from whence draw the Line H F parallel to the Side A C, which shall divide the Triangle given, according as was required.

But of this see more in the laying out of Lands.

PROB. XXII.

From a Line given, to cut off any Parts required.

THE Line given is A B, (*fig.* 30.) from which it is required to cut off ⅖ parts.

First, draw the Line A C, making any Angle, as C A B; then from A set off any seven equal parts, as 1 2 3 4 5 6 7, and from 7 draw the Line 7 B. Now because ⅖ is to be cut off from the Line A B; therefore from the Point 3, draw the Line 3 D parallel to 7 B, cutting the Line A B in D; so shall A D be ⅖ of the Line A B, and D B shall be ⅗ of the same Line. For,

As A 7, is to A B : : so is A 3, to A D.

PROB. XXIII.

To find a mean proportional between two Lines given.

IN Figure 31, let the two Lines given be A and B, between which it is required to find a mean proportional.

Let the two given Lines A and B be joined together in the point E, making one right Line, as C D, which divide into two equal parts in the point G, upon which point G, with the Distance G C or G D, describe the Semicircle C F D; then, from the point E,

(where

(where the two Lines are joined together) raiſe the Perpendicular E F, cutting the Periferie of the Semicircle in F; ſo ſhall the Line E F be a mean Proportional between the two given Lines A and B. For,

As E D to E F : : ſo E F to C D.
9 12 12 16

In Numbers, thus multiply the Numbers expreſſing the given Lines together, and extract the Square Root of the Product, which Root gives the Length of the mean Proportional ſought.

PROB. XXIV.

How to find two Lines, which together ſhall be equal in power to any Line given, and in power the one to the other, according to any Proportion aſſigned.

IN Figure 31. let C D be a Line given, whoſe Power ſhall be equal to the Sum of the Powers of two ſought lines, which ſhall be to one another as A to B.

Firſt, divide the Line C D in the point E, in proportion as A to B, *(by the 12th Problem)* then divide the Line C D into two equal parts in the point G, and on G at the Diſtance G C or G D, deſcribe the Semicircle C F D, and upon the point E, raiſe the perpendicular E F, cutting the Semicircle in F. Laſtly, draw the Lines C F and D F, which together in power ſhall be equal to the power of the given Line C D, and yet in power one to the other as A to B.

PROB. XXV.

How to divide a Line in power according to any proportion given.

FIrſt, divide the Line C D (*fig.* 32.) in the point E, in proportion as A to B; then divide the Line C D in two equal parts in the point G; and upon G, as a Center, at the Diſtance G D deſcribe the Semicircle C F D, and on the point E raiſe the perpendicular E F, cutting the Semicircle in F; then draw the Lines

Lines C F and D F, and produce the Line C F to H, till F H be equal to F D, and draw the Line H D and F K parallel thereunto: then shall the Line C D be divided in K, so that the Square of C K shall be to the Square of K D, as C E to E D, or as B to A.

PROB. XXVI.

How to enlarge a Line in power according to any proportion assigned.

IN Fig. 32, let C E be a Line given, to be enlarged in power, as the Line B to the Line G.

First, *(by the 12th Problem)* find a Line in proportion to the given Line C E, as B is to G, which will be C D; upon which Line describe the Semicircle C F D, and on the point E erect the perpendicular E F; then draw the Line C F, which shall be in power to C E, as G to B.

PROB. XXVII.

To enlarge or diminish a Plot given according to any Proportion required.

LET A B C D E *(fig. 33.)* be a Plot given, to be diminished in Power as L to K.

Divide one of the Sides (as A B) in power as L to K, in such sort, that the power of A F, may be to the power of A B, as L to K. Then from the Angle A, draw Lines to the points C and D; that done, by F draw a Parallel to B C, to cut A C in G, as F G. Again, from G draw a parallel to D C, to cut A D in H. Lastly, from H draw a parallel to D E, to cut A E in I; so shall the Plot A F G H I be like A B C D E, and in proportion to it, as the Line K to the Line L, which was required.

Also, if the lesser Plot were given, and it were required to make a greater in proportion to it, as K to L: Then from the point A, draw the Lines A C and A D at length, also increase A F, and A I; that done, enlarge A F in power as L to K, which set from A to B, then

then by B draw a parallel to F G, to cut A C in C, as B C. Likewiſe from C draw a parallel to G H, to cut A D in D, as C D, Laſtly, a Parallel from D to H I, as D E, to cut A I being increaſed in E, ſo ſhall you include the Plot A B C D E, like A F G H I, and in proportion thereunto, as the Line K is to the Line L, which was required.

PROB. XXVIII.

How to make a Triangle, which ſhall contain any number of Acres, Roods and Perches, and whoſe Baſe ſhall be equal to any (poſſible) number given. See Fig. 34.

IF it be required to make a Triangle, which ſhall contain 5 Acres, 2 Roods, 30 Perches, whoſe Baſe ſhall contain 50 Perches, you muſt firſt reduce your 5 Acres, 2 Rood, 30 Perches, all into Perches in this manner.

Firſt, (becauſe 4 Roods make one Acre) multiply your 5 Acres by 4, which makes 20; to which add the two odd Roods, ſo have you 22 Roods in your 5 Acres, 2 Roods. Then (becauſe 40 Perches make one Rood) multiply your 22 Roods by 40, which makes 880 Perches; to which add the 30 odd Perches, and you ſhall have 910, and ſo many Perches are contained in 5 Acres, 2 Roods, 30 Perches.

Now, to make a Triangle, which ſhall contain 910 Perches, and whoſe Baſe ſhall be 50 Perches, do thus; double the number of Perches given, namely, 910, and they make 1820; then, becauſe the Baſe of the Triangle muſt contain 50 Perches, divide 1820 by 50, the Quotient will be 36½, which will be the Length of the Perpendicular of your Triangle. This done, from any equal Scale lay down the Line A B equal to 50 Perches; then upon B, raiſe the perpendicular B D equal to 36½ Perches, and draw the Line C D parallel to A B; then, from any point in the Line C D, (as from E) draw the Lines E A and E B, including the Triangle A E B, which ſhall contain 5 Acres, 2 Roods, 30 Perches, which was required.

In like manner, if the Lines E B A B, and alſo the point E, were given in Poſition, and it be required to draw from E, the Line E A; ſo that the Triangle E A B may contain 910 Perches, and the neareſt Diſtance of E from the Line B A be 36 Perches and ½; then divide 1820, the double of 910, and the Quotient 50

gives the Length of B A; therefore make B A 50 Perches, and draw E A, and ſo will the Triangle E A B contain as required.

PROB. XXIX.

How to reduce a Trapezia *into a* Triangle, *by a Line drawn from any Angle thereof.*

THE Trapezia given is A B C D, (*fig.* 35.) and it is required to reduce the ſame into a Triangle.

Firſt, extend the Line D C, and draw the * Diagonal B D; then from the point A draw the Line A E, parallel to B D, extending it till it cut the ſide C D extended, in the point E. Laſtly, from B, draw the Line B E, conſtituting the Triangle E B C, which ſhall be equal to the Trapezia A B C D.

PROB. XXX.

How to reduce a Trapezia *into a* Triangle, *by Lines drawn from any Point in any of the ſides thereof.*

LET A B C D (*fig.* 36.) be a Trapezia given, and let H be a point in one of the ſides thereof, from which point H let it be required to draw Lines, which ſhall reduce the Trapezia into a Triangle.

Firſt, extend the ſide which is oppoſite to the given point, namely, the ſide C D, both ways to E and F, and farther if need require; and then from the point H, draw Lines to the Angles C and D, as the Lines H C and H D; alſo draw the Lines A E and B F parallel to H C and H D, cutting the extended Line C D in the points E and F. Laſtly, if from the point H you draw the Lines H E and H F, you ſhall conſtitute the Triangle H E F, which ſhall be equal to the Trapezia A B C D.

* A *Diagonal Line* is a Line drawn from any Angle of a Figure, to the oppoſite Angle of the ſame Figure.

PROB.

PROB. XXXI.

How to reduce an irregular Plot of five Sides into a Triangle.

THE irregular Plot given is A B C D E, (*fig.* 37.) and it is required to reduce the ſame into a Triangle.

Firſt, extend the Side A E both ways to F and G; and from the Angle C, draw the Lines C A and C E, to the Angles A and E: Then from the point B, draw the line B F parallel to C A, cutting the extended ſide A E in F; alſo from the point D, draw the line D G parallel to C E, cutting alſo the extended Side A E in G. Laſtly, from the Angle C, draw the lines C F and C G, conſtituting the Triangle C F G, which is equal to the Plot A B C D E.

PROB. XXXII.

How to reduce an irregular Plot of 6, 7, or 8 Sides into a Triangle.

LET A B C D E F G, (*fig.* 38.) be an irregular Plot given, to be reduced into a Triangle.

I have choſen this Figure, where the Angles C and F are without the Field, becauſe it often comes in practice, and hath not been taught by any to my knowledge.

Firſt, draw the line B D, and parallel thereto the line C K; then if you draw the line B K, it will cut off from the Figure the Triangle D K S, and will take in the Triangle B C S equal thereunto, and the ſide B K will ſupply the uſe of the two ſides B C and C D. Alſo draw the line G E, and parallel thereto F L; then if you draw the line G L, it ſhall cut off from the Figure the Triangle L R E, and take in the Triangle G R F eqnal thereto, and the line or ſide G L will ſupply the uſe of the other two ſides G F and F E, and ſo the whole Plot A B C D E F G (conſiſting of ſeven ſides) is reduced to a Figure of five ſides, namely, into the Figure A B K L G, yet ſtill retaining thc ſame Quantity. Now to reduce this Plot into a Triangle, you muſt work in all reſpects as in the former Problem. Firſt, produce the ſide D E of the given Figure, on both ſides to H and M; then draw the lines A K and A L,

A L, and parallel to them the lines B H and G M, cutting the line D E (being extended) in H and M. Laſtly, if you draw the lines A H and A M, you ſhall conſtitute the Triangle A H M, which ſhall be equal to the irregular Plot A B C D E F G, which was required.

¶ And here note, that if the number of ſides be never ſo many, yet this way of reduction will bring them to Triangles.

PROB. XXXIII.

A Trapezia *being given, how from any Angle thereof to divide the ſame into two parts, being in proportion one to the other, as two given right Lines, and to ſet the part cut off towards an aſſigned ſide.*

LET the Trapezia given be A B C D; (*fig.* 39.) and let it be required to draw a line from the angle B, which ſhall divide the Trapezia into two parts, being in proportion one to the other, as the line G is to the line H; and that the leſſer part of the figure cut off, may lye towards the ſide A B.

Firſt, (*by the* 29*th Problem*) reduce the Trapezia A B C D into a Triangle, by drawing the line B F from the aſſigned angle, thereby conſtituting the Triangle A B F, equal to the Trapezia ABCD; this done, divide the Baſe of the Triangle A F in proportion as G to H, which will be in the point E, Laſtly, draw the line B E, which ſhall divide the Trapezia in proportion as G to H. Now becauſe the leſſer part of the Trapezia was to be ſet towards the ſide A B, therefore the leſſer part of the line muſt be ſet from A to E. But, as in this Problem, ſo in all thoſe that follow, we muſt continue that line on which the partition falls, in order to reduce it to a Triangle, otherwiſe this method of parting will not ſucceed.

¶ Here note, that the ſame manner of working is to be obſerved, if it had been required to divide the Trapezia by a line drawn from any of the other Angles.

PROB

PROB. XXXIV.

A Trapezia *being given, how, from a point given in any ſide thereof, to draw a Line, which ſhall divide the ſame into two parts, in proportion as two given Lines.*

THE Trapezia given is A B C D (*fig.* 40.) and it is required from the Point H to draw a Line, which ſhall divide the Trapezia in proportion as O to Q.

Firſt, prolong the ſide C D, and reduce the whole Trapezia into the Triangle H E F (*by the 29th Problem*); then divide the line E F in proportion as O to Q, which will fall in the point G; therefore draw the line H G, which ſhall divide the Trapezia into two parts in proportion as O to Q, which was required.

In this, as in the foregoing, if the point G had fallen between C and E, the line A C muſt have been produced inſtead of D C; and then the point G would have fallen between C and A.

PROB. XXXV.

A Parapezia *being given, how to divide the ſame into two parts in proportion to two lines given, and ſo that the line of partition may be parallel to any ſide thereof.*

THE Trapezia given is A B C D, (*fig.* 41.) and it is required to divide the ſame into two parts, which ſhall be in proportion one to the other, as the line K is to the line L, and that the line of partition may be parallel to the ſide B D.

Conſider firſt, through which ſide of the Trapezia the line of Partition will paſs, as in this figure it will paſs through the ſides A B and C D (becauſe parallel to B D); therefore extend the ſides A B and C D, till they concur in E; then (*by the 29th Problem*) reduce the Trapezia A B C D into the Triangle B G D, whoſe Baſe is G D, which line G D divide in the point H in proportion as K to L; ſo that,

As K to L : : So D H to H G.

This done, find a mean proportional between E D and E H, *(by the 23d Problem)* as E R. Laſtly, through this point R, draw the line R F parallel to B D, which ſhall divide the Trapezia into two Parts, being in proportion one to the other, as the line K is to the line L, and with a line parallel to the ſide B D, which was required.

But if it had been required to divide the Trapezia by a line drawn parallel to the ſide C D; then the lines C A and D B muſt have been extended, but the reſt of the work muſt be performed, as is before taught.

PROB. XXXVI.

The Figure of a Plot *being given, how to divide the ſame into two parts, being in proportion one to the other, as two given lines are, with a line drawn from an Angle aſſigned.*

LET the Figure A B C D E *(fig. 42.)* repreſent the *Plot* of a *Field*, or ſuch like; and let it be required to divide the ſame into two parts, being in proportion one to the other, as the line R is to the line S, by a line drawn from the Angle B.

Firſt, reduce the *Plot* A B C D E, into the Triangle B F G, *(by the 31ſt Problem)* ſo ſhall the line F G be the Baſe of a Triangle equal to the given *Plot*; then *(by the 12th Problem)* divide this line F G into two parts in the point H, in proportion one to the other, as the line R is to the line S; ſo that,

As R to S : : So G H to H F.

Laſtly, draw the line B H, which ſhall divide your given *Plot* into two parts, which ſhall have ſuch proportion one to the other, as the line R hath to the line S.

If H (in this work) falls between $\left\{\begin{matrix}\text{D and G}\\\text{E and F}\end{matrix}\right\}$ then the Figure muſt be reduced to a Triangle, by producing $\left\{\begin{matrix}\text{D C}\\\text{A E}\end{matrix}\right\}$ and ſo then G will fall between $\left\{\begin{matrix}\text{D and C}\\\text{A and E}\end{matrix}\right\}$

PROB.

PROB. XXXVII.

How to divide a Triangle into any number of equal parts, by lines drawn from a point given in any ſide thereof.

LET it be required to divide the Triangle A B C, (*fig.* 43.) into five equal Parts, by lines drawn from the point D.

Firſt, from the given point D, to the oppoſite Angle B, draw the line D B; then divide the ſide A C of the Triangle into five equal parts, as E, F, G and H; and through each of thoſe points, draw lines parallel to D B, as E M, F L, G K, and H I; then from the point D, draw the lines D I, D K, D L, and D M, which ſhall divide the Triangle A B C into five equal parts from the point D, as was required.

PROB. XXXVIII.

How to divide an irregular Plot of ſix ſides, into two parts, according to any aſſigned proportion by a right line drawn from a point limited in any of the ſides thereof.

THE irregular Plot given is A B C D E F, (*fig.* 44.) and it is required to divide the ſame into two parts, being in proportion one to the other, as the line R is to the line S.

Firſt, draw the right line H K, and (*by the 29th Problem*) reduce the Trapezia A B F C into the Triangle H G K, then divide the Baſe thereof, namely, H K, into two parts in proportion as R to S, which will be in the point O; then draw the line G O, which will divide the Trapezia A B F C into two parts in proportion one to the other, as the line R is to the line S.

Secondly, from the point O (*by the 29th Problem*) reduce the Trapezia F C E D into the Triangle O L M, and divide the Baſe thereof, namely, L M in the point N, in proportion as R to S, and draw the line O N, which will divide the Trapezia F C E D into two parts in proportion as R to S: and by this means is the whole Plot A B C D E F divided into two parts in proportion as R to S, by the lines G O and O N. But it is required to reſolve the

the Problem by one right line only drawn from the point G; therefore from the point G, draw the line G N, and through the point O, draw the point O P parallel to G N: and laſtly, from G draw the right line G P, which ſhall divide the whole Plot A B C D E F into two parts, being in proportion one to the other as the line R is to the line S.

PROB. XXXIX.

How to divide an Irregular Plot *according to any proportion, by a line drawn from any angle thereof.*

LET A B C D E F G, (*fig.* 45.) be an *Irregular Plot*, and let it be required to divide the ſame into two equal Parts, by a line drawn from the Angle A.

Firſt, draw the line H K, dividing the *Plot* into two parts; namely, into the five-ſided Figure A B C F G, and into the Trapezia F C E D, then (*by the* 31*ſt Problem*) reduce the five-ſided Figure A B C F G into the Triangle H A K, the Baſe whereof H K divide into two equal Parts in O, and draw the line O A, which ſhall divide the five-ſided Figure A B C F G into two equal parts. Then (*by the* 29*th Problem*) reduce the Trapezia F C D E into the Triangle O L M, and divide the Baſe thereof L N into two equal parts in the Point P, and draw the Line O P, which will divide the Trapezia F C D E into two equal parts by the lines A O and O P: but to perform this Problem by one right line only, do thus; from the point A, draw the line A P, and parallel thereunto, through the point O, draw the line O N. Laſtly, if you draw a right line from A to N, it ſhall divide the whole Plot into two equal parts.

¶ Here note, that whatſoever hath been ſaid concerning the dividing of Figures in proportion to right lines, the ſame may be effected in numbers, ſo that from any *Plot* you may cut off any number of *Acres*, *Roods*, or *Perches*.

PROB.

PROB. XL.

How to divide a Trapezia *into two parts, by a line drawn from a point without, which parts shall be in proportion one to the other, as two given lines.*

LET the Trapezia given be A B C D (*fig.* 46.) and let the given point without be E, from which it is required to draw line, which shall divide the Trapezia into two parts, which shall e in proportion one to the other, as the line F is to the line G. Extend the sides of the Trapezia B C and A D, till they concur H; then through the point E draw the line E I parallel to A H, ll it meet with the line B H being extended to I; then (*by the 9th Problem*) reduce the Trapezia ABCD into the Triangle ABK, nd from the point B let fall the perpendicular B Z; then (*by the 2th Problem*) divide the Baſe of the Triangle A K into two parts, proportion as F to G, which point of Diviſion will fall in L. his done, find a fourth Line, which will be in proportion to theſe ree Lines I E, H L, and HB, that is, as I E to H L: , ſo H B H M, ſo is H M the fourth proportional; then (*by the 23d Problem*) find a mean proportional between the lines I H and H M, hich is H N; then ſet H N perpendicular upon B H, and divide M into two equal Parts in O, then draw the Line O N, which ou ſhall ſet from O to P. Laſtly, if you draw the Line E P, it all divide the Trapezia A B C D into two parts, which ſhall be proportion one to the other, as the line F is to the line G.

PROB. XLI.

From any Irregular Plot, *to cut off therefrom any (poſſible) number of* Acres, Roods, *and* Perches, *and that by a ſtrait Line drawn from any Angle of the* Field.

LET ABCDEFGHK, (*fig.* 47.) be a Field given, containing 15 Acres and 14 Perches, and let it be required to cut ff from the ſame Field 5 Acres and 12 Perches, and that by a ight line drawn from the Angle C.

First, reduce the 15 Acres, 14 Perches all into Perches (as is taught in the fourth Book) and they make 2414. Also reduce the 5 Acres and 12 Perches into Perches, and they make 812.

Secondly, from the Angle C draw a right line to any other Angle of the Field, which may seem most convenient for your Purpose, as to G, by which line C G, you have cut off a part of the Field, *viz.* the part C D E F G.

Thirdly, find (as is hereafter taught) how many Perches is contained in the Part cut off C D E F G, which suppose to be 700; but the part of the Field to be cut off should contain 812 Perches, too little by 112 Perches, and therefore the line C G is not the true line of Division, but is drawn too much towards the Angle F. Wherefore to find the true line of Division, you must,

Fourthly, measure the Length of the line C G (by the same Scale as you cast up your Plot by) and you shall find it to contain 36 Perches in Length, the half whereof is 18. By which divide 112 (the Difference before found) and the Quotient will be six Perches $\frac{2}{9}$ of a Perch. Wherefore,

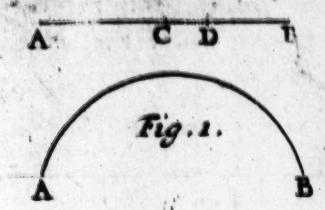
Fifthly, take 6 $\frac{2}{9}$ Perches from your Scale, and with what distance, from the points C and G, draw a line parallel to your first supposed line C G, as the line L O, cutting the side of the Plot H G in O.

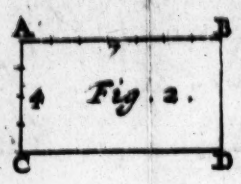
Lastly, draw the right line C O, and it shall be your true line of Separation. And so that part of the Plot inclosed by the lines C D, D E, E F, F G, and G O, shall contain 812 Perches, or 5 Acres and 12 Perches. And the other part of the Plot inclosed by the Lines C B, B A, A K, K H, and H O, shall contain 1602 Perches, or 10 Acres and 2 Perches.

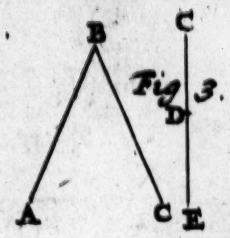
The End of the First Book.

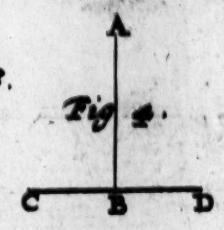
THE

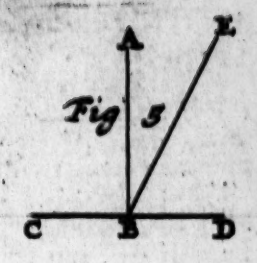
Book. 2 Plate. 1.

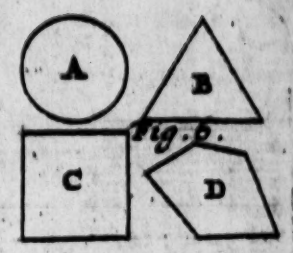


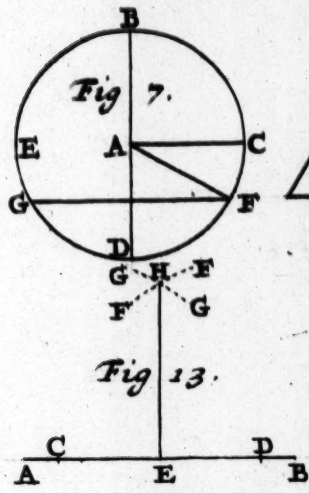


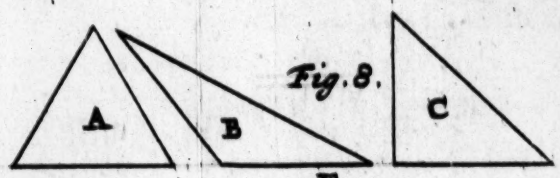


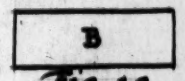


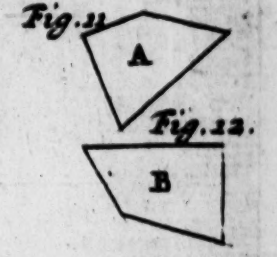


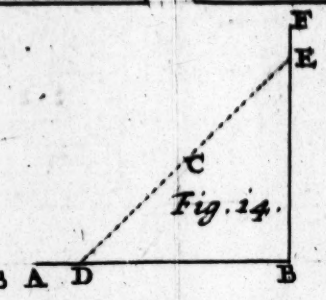


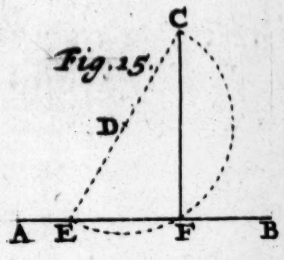


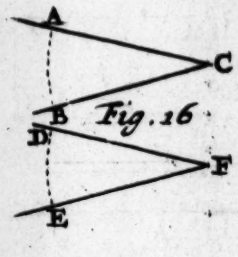


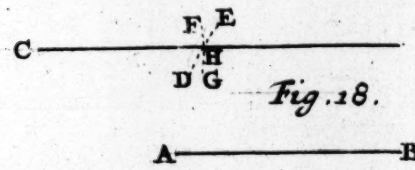


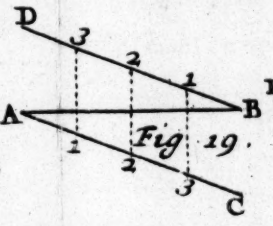


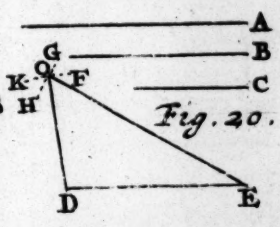


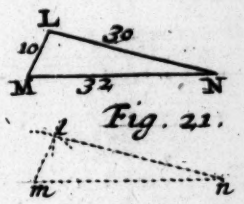


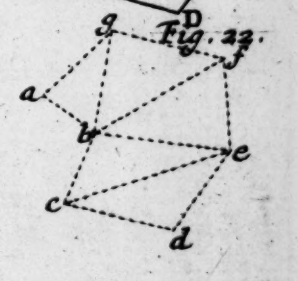


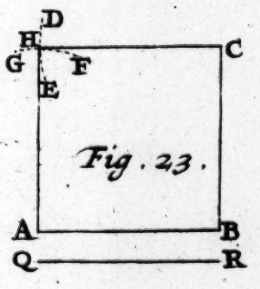


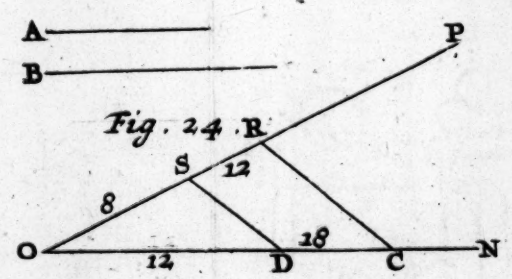


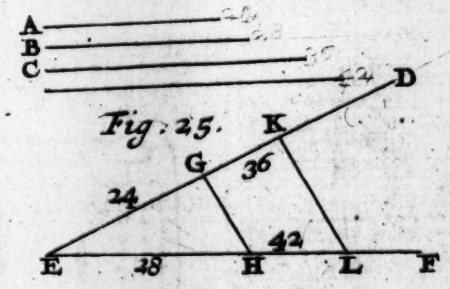


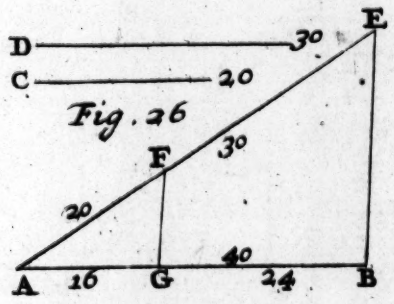


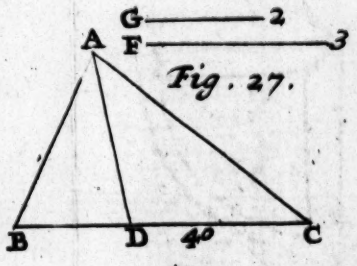


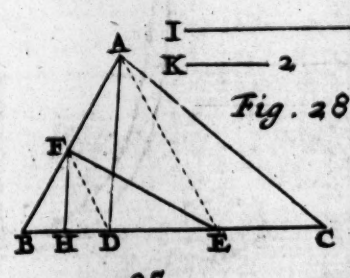


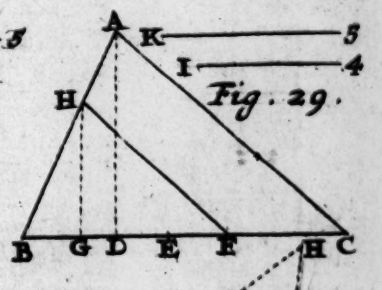


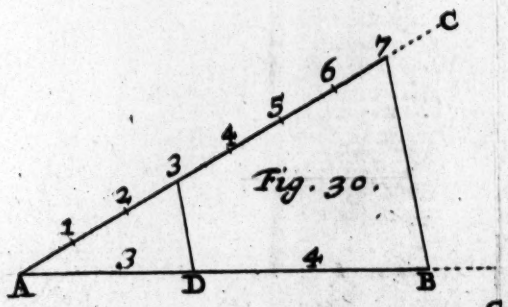


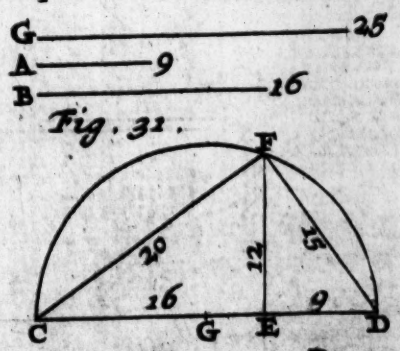


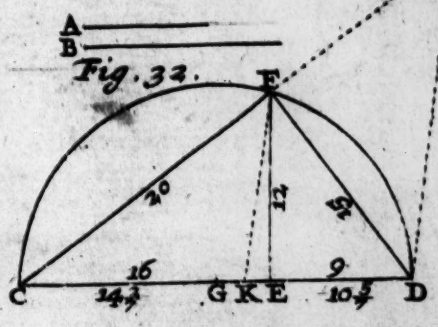


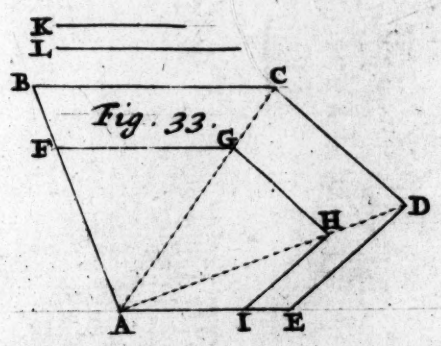


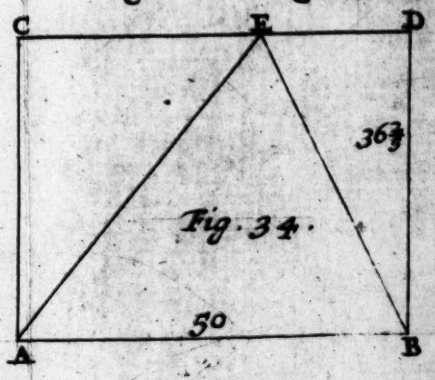


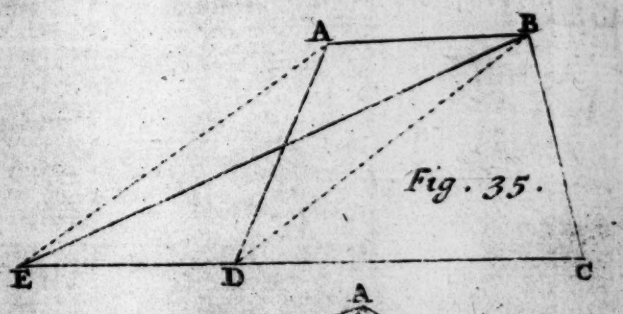


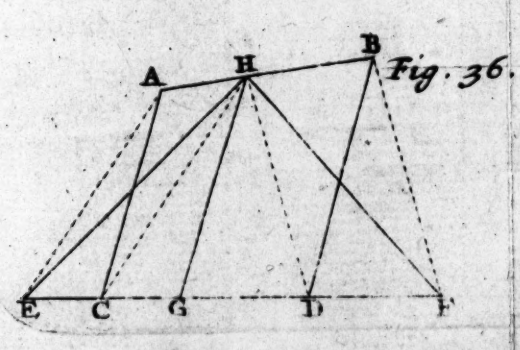


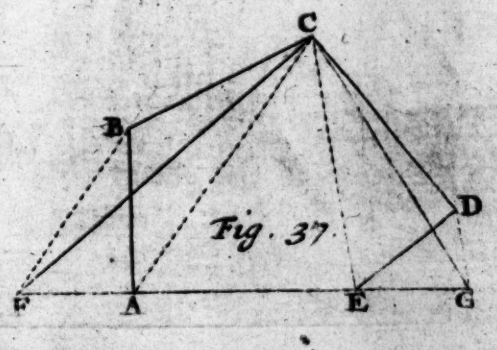


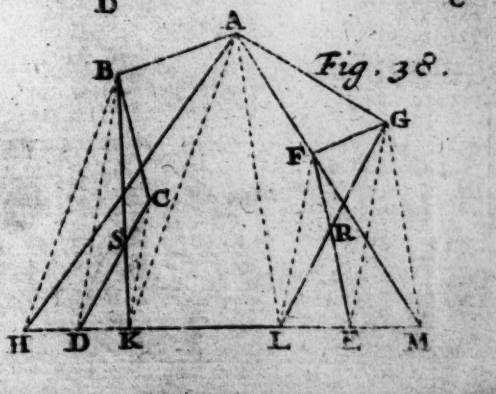


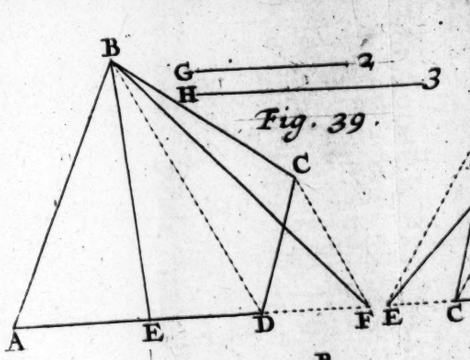












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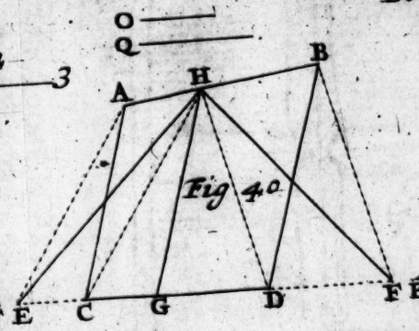

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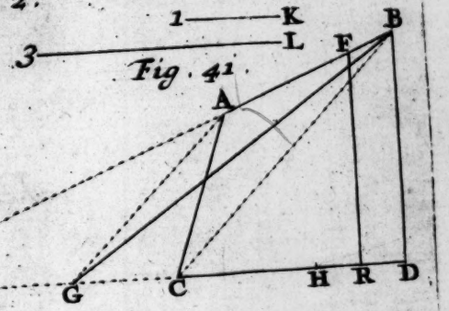

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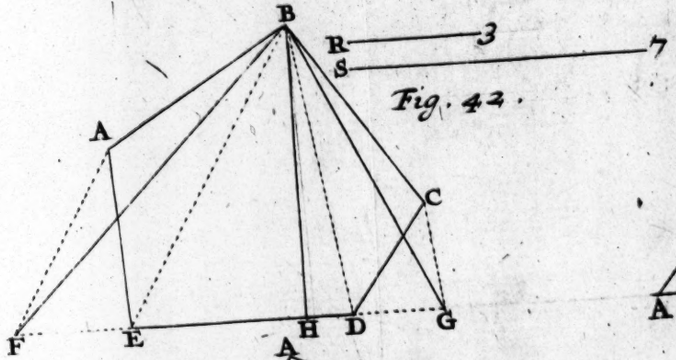

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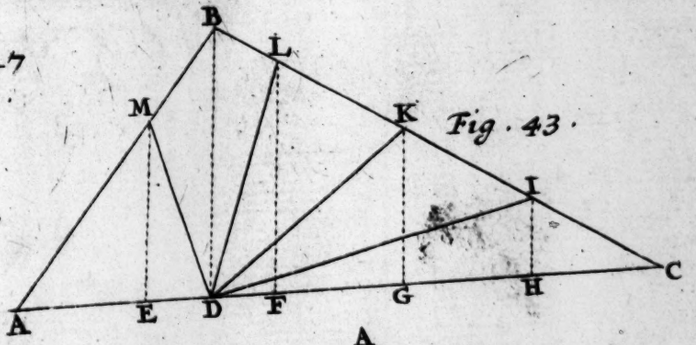

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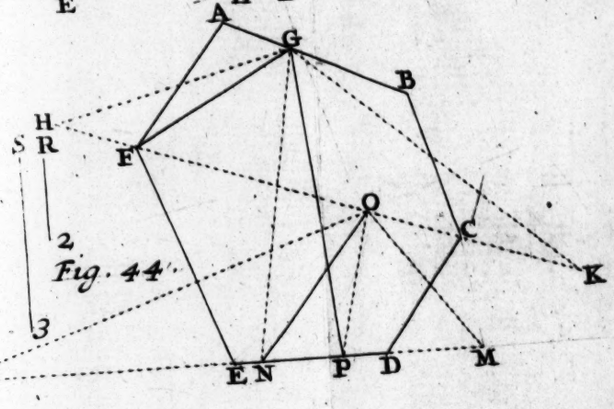

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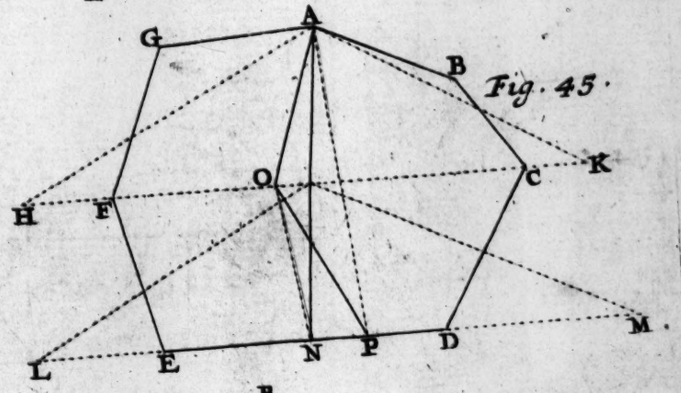

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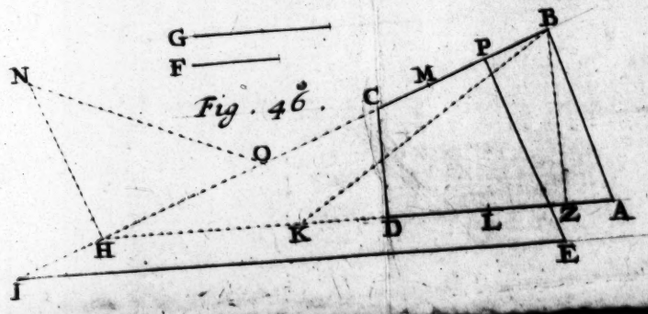

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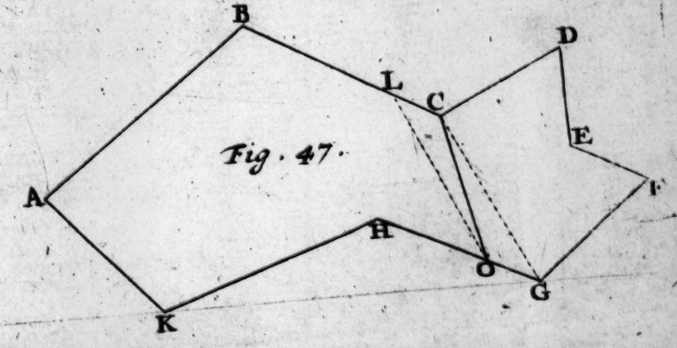


Fig. 47.

Book 3.

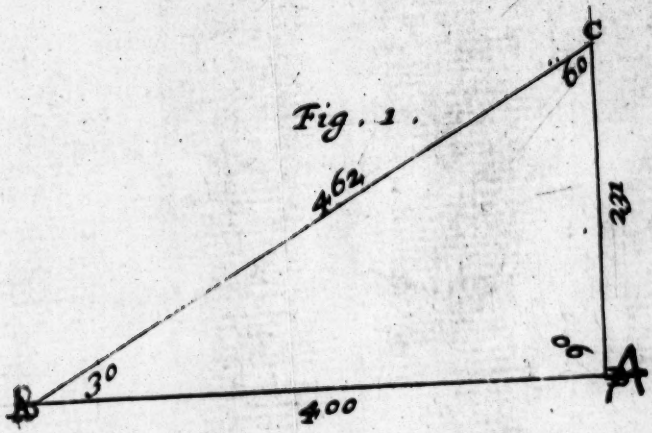


Fig. 1.

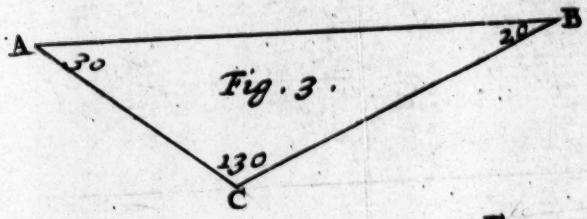
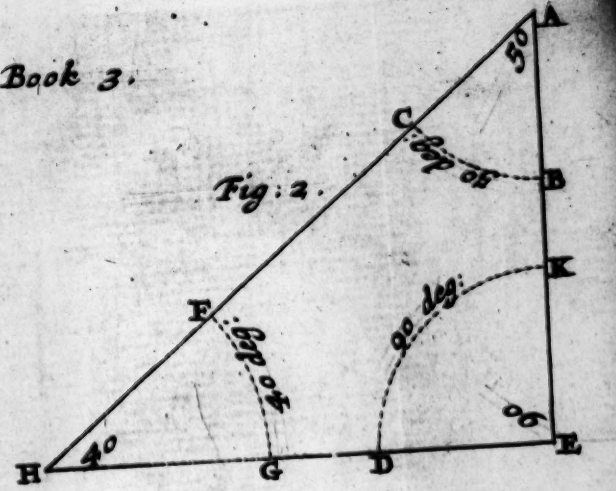
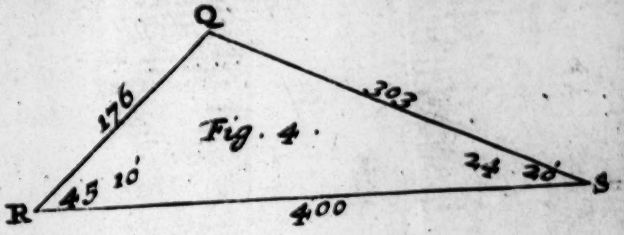
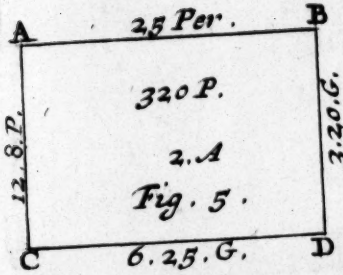
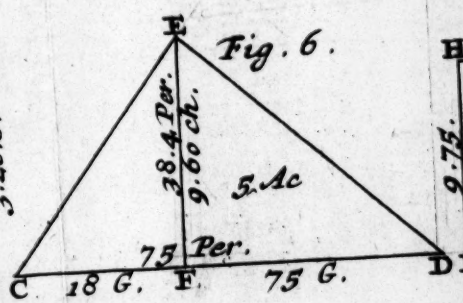


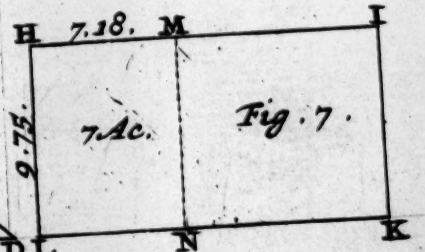
Fig. 3.











The COMPLEAT SURVEYOR.

The Second Book.

The ARGUMENT.

IN *this* Book *is contained both a general and particular Deſcription of all the moſt neceſſary* Inſtruments *belonging to* Surveying, *as the* Theodolite, Circumferentor, *and* Plain Table, *with all the Appurtenances thereunto belonging, as the* Staff, Sockets, Screws, Index, Label, *and other Neceſſaries. Now, whereas theſe three Inſtruments are the moſt convenient for all manner of Practices in* Surveying, *I have ſo ordered the Matter, that in this* Book, *after the* Plain Table, Theodolite, *and* Circumferentor *are particularly deſcribed, as they have uſually been made; I come to another Deſcription of the* Plain Table, *and therein have ſhewed how*

that

that Instrument *may be order'd to perform the Work of any of the other; so that whatsoever may be done by the* Theodolite. Circumferentor, *or any other* Instrument, *the same may be effected by the* Plain Table *only, as it is here contriv'd, with the same Ease, Dispatch, and Exactness, and in many respects better, as in* chap. 1 *doth plainly appear: so that this* Instrument *only is sufficient for all manner of Practices whatsoever. And besides the forementioned* Instuments *for* Mensuration, *there is described divers other* Instruments *belonging thereunto, as* Chains, Scales, Protractors, *and the like; all which are describ'd and figur'd, according to the best Contrivance yet known. Unto these Instruments I have (in this Edition) added the Use of another Instrument very portable; the which will perform with Exactness all the Uses that can be effected, either by* Circumferentor, Theolodite, *or* Peractor. *And whereas in the Description of the* Plain Table, *thus altered, I do commend it above all other, because indeed it comprehendeth, and performeth the Work of any other yet invented; yet notwithstanding I do not enjoyn every Man to have his Instrument so absolute; for that (for many Purposes) the* Semicircle *or* Circumferentor *is more convenient. And (in all Cases) the* Perambulator, *whose Description and Use is in this Edition added at the End of the Fourth Book, exceedeth them all, as in the Uses of it will appear.*

A DESCRIPTION OF INSTRUMENTS.

CHAP. I.

Of INSTRUMENTS *in general.*

THE particular Deſcription of the ſeveral Inſtruments, that have from time to time been invented for the Practice of Surveying, would make a Treatiſe of it ſelf, and in this Place is not ſo neceſſary to be inſiſted on, every of the Inventors, in their particular Treatiſes, having been large in their Conſtruction. To omit herefore the Deſcription of the *Topographical Inſtrument* of Mr. *Leonard Diggs*, the *Familiar Staff* of Mr. *John Blagrave*, the *Geodetical Staff* and *Topographical Glaſs* of Mr. *Arthur Hopton*, with ivers other Inſtruments invented and publiſhed by *Gemma*, *Frius*, *Orontius*, *Clavius*, *Stoſlerus*, and others; I ſhall immediately egin with the Deſcription of thoſe which are the Ground and oundation of all the reſt, and are now the only Inſtruments in moſt Eſteem amongſt Surveyors; and thoſe are cheifly theſe three, the *heodolite*, the *Circumferentor*, and the *Plain Table*. Now, as I

would not confine any Man to the Uſe of one particular *Inſtrument* for all Employments, ſo I would adviſe any Man not to cumber himſelf with Multiplicity, ſince theſe three laſt named are ſufficient for all Occaſions. And if I ſhould confine any man to the Uſe of any of theſe Inſtruments, (as for a ſhift, any one of them will perform any kind of Work in Surveying;) yet in that I ſhould do him Injury; for in many Caſes one Inſtrument may make a quicker Diſpatch, and be altogether as exact as another. As in laying down of a ſpacious Buſineſs, I would adviſe him to uſe the *Circumferentor*, *Theodolite*, or *Perambulator*, and for Townſhips and ſmall Incloſures the *Plain Table*, ſo altering his Inſtrument, according as the Nature or Quality of the Ground he is to meaſure, doth require.

Theſe three ſpecial Inſtruments have been largely deſcribed already by divers, as namely, by Mr. *Diggs*, Mr. *Hopton*, Mr. *Rathborn*, and laſt of all in my *Planometria*; yet in this place it will be very neceſſary to give a particular Deſcription of them again, becauſe if any Man have a Deſire to any particular Inſtrument, he may give the better Directions for the making thereof.

For the Deſcription of which I ſhall make uſe of theſe three Inſtruments in particular, it ſhall be agreeable to thoſe Inſtruments, as they are uſually made, with ſome ſmall Addition or Alteration. But when I come to the Deſcription of the *Plain Table*, after that I have deſcrib'd it according to the vulgar way, I will then ſhew you a new *Metamorphoſis* of that Inſtrument, making it the moſt abſolute and univerſal Inſtrument ever yet invented; ſo that having that one Inſtrument (made according to the following Direction) you ſhall have need of no other for the due, exact, and ſpeedy Performance of any thing belonging to the Art of Surveying. For the Frame of the Table being graduated according to that Deſcription, it will be an abſolute *Theodolite*, and perform the Work thereof with the ſame Facility and Exactneſs; and whatſoever may be done by the Limb of the *Theodolite*, the ſame the Degrees on the Frame of the Table will as well perform.

The Plain Table uſed as the Theolodite.

Likewiſe the Index and Sights, together with the Box and Needle, being taken from the Table, and ſcrew'd to the Staff (as in the Deſcription thereof it is ſo conveniently order'd) will be an abſolute *Circumferentor*, and in ſome reſpects better than the ordinary one hereafter deſcribed, becauſe the Sights thereof ſtand at a greater Diſtance, ſo that thereby the viſual Line may be the better directed.

The Plain Table uſ'd as a Circumferentor.

And this Inſtrument (as now contrived) though it be called the *Plain Table* only, yet you ſee that it contains both the other; and therefore in adviſing any Man to the Uſe thereof chiefly, I do not confine him to one, but to all Inſtruments, and therefore do not contradict my former Expreſſion.

The Plain Table not one, but all Inſtruments.

Beſides,

Besides, there is another great Convenience, which doth ensue by the Degrees on the Table's Frame; for in taking the Plot of a Field, according to the Following Directions, by the *Plain Table*, you may at the same time perform, the same work by the Degrees on the Frame, of the Table, if at the Drawing of every Line you observe the Degrees cut by the Index, and note them upon the Paper. This, I say, is a great Convenience, for at one Observation you perform two works with the same Labour, as by the uses of these Instruments, severally, will appear. And what benefit a Surveyor, will receive by having all Instruments in one, I shall refer to himself to judge.

CHAP. II.

Of the Theodolite, *the Description thereof, and the Detection of an Error frequently committed in the making thereof, with the manner how to correct the same.*

THE *Theodolie* is an Instrument consisting of four Parts principally. The first whereof is a Circle, divided into 360 equall Parts, called Degrees, and each Degree subdivided into as many other equal Parts, as the largeness of the Instrument will best permit. For the Diameter of this Circle, it may be of any length, but those usually made in Brass are about 12 or 14 Inches, and the Limb thereof Divided as aforesaid into 360 Degrees, and sub-divided into other Parts by Diagonal Lines, drawn from the outmost, and inmost concentrick Circles of the Limb.

The Second Part of this Instrument is the Geometrical Square, which is described within the Circle, and the sides thereof divided into certain equall parts: but there are few of them made now with this Square, for the degrees themselves will better supply that want, it being only for taking of heights and distances.

The third part of this instrument is the Box and Needle, so conveniently contrived to stand upon the Center of the Circle, upon which Center also the Index of the Instrument must turn about: and sometimes over the Box and Needle there is a Quadrant erected for the taking of heights and distance.

The fourth part of this Instrument is a Socket, to be screwed on the back-side of the Instrument, to set it upon a Staff when you make use thereof. In the making of this Instrument, it were Necessary to have two back-sights fixed at each end of one of the Diameters, for the readier laying out of any Angle without moving of the Instrument.

CHAP.

CHAP. III.

The Deſcription of the Circumferentor.

THIS Inſtrument, hath been much eſteemed by many, for the Portability thereof, it being uſually made to contain in Length about 8 Inches, in Breadth 4 Inches, and in Thickneſs about three Quarters of an Inch; one ſide whereof is divided into divers equal Parts, moſt fitly of 10 or 12 in an Inch; ſo that it may be uſed as the Scale of a *Protractor*, the Inſtrument it ſelf being fitting to protract the Plot on Paper by help of the Needle, and the Degrees of Angles, and Length of Lines taken in the Field. On the upper ſide of this Inſtrument is turn'd a round Hole, three Inches and a half Diameter, and about half an Inch deep, in which is placed, a Card Divided commonly into 120 Equal Parts, or Degrees, and each of thoſe into 3, which makes 360, anſwerable to the Degrees of the *Theodolite*. In which Card is alſo a Dial Drawn, to find the Hour of the Day, and Azimuth of the Sun. Within the Box is hanged, a Needle touched with a Load-ſtone, and covered over with a clear Glaſs to preſerve it from the Weather.

On the upper Part of this Inſtrument is alſo deſcribed a Table of natural Sines, collected anſwerable to the Card in the Box: that is to ſay, if the Card be divided but into 120 Parts, the Sines muſt be ſo alſo; but if into 360, the Sines muſt be the abſolute Degrees of the Quadrant.

To this Inſtrument alſo do belong two Sights, one double in Length to the other, the Longeſt Containing about 7 Inches, being placed and divided in all Reſpects, as thoſe hereafter mentioned in the Deſcription of *Plain Table*. On the Edge of the ſhorter Sight, toward the upper Part thereof, is placed a ſmall Wire repreſenting the Center of a Suppoſed Circle, the Semidiameter whereof is the Diſtance from the Wire, to the Edge of the Inſtrument underneath the ſame, which Parts are imaginarily divided into 60 equal Parts: and according to thoſe Diviſions is the Right-line of Diviſions, on the edge of the Inſtrument divided, and numbred by 5, 10, 15, from the Perpendicular Point to the end thereof. And alſo from the ſame Point on the upper Edge of the Inſtrument is perfected the Degrees, of the Quadrant, ſupplying the Reſidue, of thoſe which could not be expreſſed on the Long Sight, from 28 to 90, by Tens.

There is alſo belonging, to theſe Diviſions a little Rular, at one end whereof is a little Hole to put it upon the Wire, on the Edge of the ſhorter Sight; and at other end of this Rular; is placed a ſmall Sight, directly over the fiducial Edge thereof, which Edge is likewiſe divided according to thoſe Diviſions on the

the edge of the Inſtrument. To this ſhort Sight is added a Plummet to ſet the Inſtrument horizontal. And this ſhort Rular, with the Diviſions thereof, and thoſe on the Edge of the Inſtrument, ſerve for taking of Altitudes chiefly, and for the Reducing of Hypotenuſal, to Horizontal Lines.

CHAP. IV.

A Deſcription of the Plain Table, *how it hath been formerly made, and how it is now altered, it being the moſt abſolute Inſtrument, of any other, for a Surveyor to uſe, in that it performeth whatſoever may be done either by the* Theodolite, Circumferentor, Peractor, Perambulator, *or any other graduated Inſtrument, with the ſame eaſe and Exactneſs.*

THE Table it ſelf is a Parallelogram, containing in Length about 14 Inches and a half, and in Breadth 11 Inches: it is compoſed of three ſeveral Boards, which may be taken aſunder for Eaſe and Convenience in Carriage. For the Binding of theſe three Boards faſt when the Table is ſet together, there belongeth a joynted Frame, ſo contrived, that it may be taken off, and put on the Table at Pleaſure. This Frame alſo is to faſten a ſheet of Paper upon the Table, when you are to deſcribe the Plot of any Field, or other Incloſure thereupon. This Frame muſt have upon it, near the inward Edge, Scales of equal Parts on both ſides, for the Speedy drawing of parallel Lines upon the Paper; and alſo for the ſhifting of your Paper, when one ſheet will not hold your whole work.

Unto this Table belongeth a Rular or Index, Containing in Length about 16 Inches or more, it being full as long as from Angle to Angle, of your Table: it ought to be about 2 Inches in Breadth, and one third Part of an Inch in Thickneſs. Upon this Rular, or Index, two Sights muſt be placed, one whereof is double in Length to the other, the Longer containing in Length about 12 Inches, the other 6. On the top of this ſhorter Sight is placed a Braſs Pin, and alſo a Thread and Plummet to

place your Inſtrument Horizontal. Through the Longer Sight muſt be made a Slit, almoſt the whole Length thereof. Theſe two Sights thus prepared, are to be perpendicularly erected upon the Index; in ſuch ſort, that the Wire on the top of the ſhorter Sight, and the ſlit on the Longer Sight, ſtand preciſely over the fiducial Edge of the Index. The Space or Diſtance of theſe two Sights, one from the other, is to be equal to the divided Part of the Longer Sight. Upon the Longer Sight is to be placed, a Vane of Braſs, to be moved up and down at Pleaſuure, through which a ſmall Hole is to be made, anſwerable to the Slit in the ſame Sight, and the Edge of the Vane.

By theſe Sights, thus placed on the Index, there is projected the Geometrical Square, whoſe ſide is the divided part of the Long Sight, (or the Diſtance between the two Sights.) In the middle of the Long Sight, (through the whole Breadth thereof) there is drawn a Line called the Line of level, dividing the ſide of the projected Square, into two equal Parts: alſo the ſame ſide is on this Sight divided into a Hundred equal Parts, which are numbered upwards and Downwards, from the Line of Level, by Fives and Tenss to Fifty, on either ſide; which Diviſions, are called the Scale.

There is alſo on the ſame Sight, another ſort of Diviſion, repreſenting, the Hypotenuſal Lines, of the ſame Square, as they increaſe by Units, and are likewiſe numbered upwards, and downwards, from the Line of Level, from 1 to 12, by 1, 2, 3, *&c.* Sometimes, ſignifying 101, 102, 103, *&c.* Theſe Diviſions ſhew how much any hypotenuſal or ſlope Line drawn over the ſame Square, exceedeth the direct Horizontal Line, being the ſide of the ſame Square.

On this Sight, there is a third ſort of Diviſions, Repreſenting the Degrees of a Quadrant, (or as many as the ſame Sight is capable to receive, which are about 25,) numbered from the line of Level, upwards and downwards, by Fives and by Tens to 25: which Diviſions, are called the Quadrant.

Unto this Inſtrument, as unto all others, belong theſe neceſſary Parts, as the Socket, the Staff, the Box, and Needle, *&c.*

¶ According to this Deſcription have *Plain Tables* formerly been made: But if unto it be added theſe additional Parts, and Alterations, (which make it leſs cumberſome, then before) it will be the moſt exact, bſolute and univerſal Inſtrument for a Surveyor, that was ever yet invented.

Firſt, Let the Frame be ſo fitted to the Table, that it may go on eaſily, either ſide being upwards; ſo that as one ſide is divided into equal Parts, (as in the Deſcription) the other ſide may have projected upon it the 180 Degrees of a Semicircle, from a Center noted in the Superficies of the Table: which De- muſt be numbred from the left hand towards the right, (when

(when the Center is next to you) by fives and tens, to 180; and then beginning again, ſet 190, and ſo ſucceſſively to 360. Theſe Degrees, thus inſerted, are of excellent uſe in wet or ſtormy Weather, when you cannot keep a ſheet of Paper upon your Table, either in reſpect of Rain or Wind. Alſo theſe Degrees will make the *Plain Table* to be an abſolute *Theodolite*; ſo that you may work with theſe Degrees as if they were the Degrees of a *Theodolite*.

Secondly, Upon the Index or Rular before ſpoken of (inſtead of the Sights before deſcribed) let there be placed two Sights, both of one length, and back-ſighted; one having a Slit below, and a Thread above, and the other a Slit above, and a Thread below, ſerving to look backward and forward at pleaſure, without turning about the Inſtrument, when the Needle is at quiet. The Expedition that theſe Back-ſights will make will beſt appear by Practice; for uſing theſe, you ſhall need (in going about a Field) to plant your Inſtrument but at every ſecond Angle.

Thirdly, For the ready taking of Heigths, and the reducing of the Hypotenuſal to Horizontal Lines, of Hills, and in taking of Altitudes, (inſtead of the Diviſions on the Sights before mention'd) let there be projected a Tangent Line along the ſide of the Rular, whoſe Diviſions muſt touch the very Edge thereof; ſo that a Label or Rular of Box or Braſs, which is hanged on a Pin ſticking in the ſide of one of the Back-ſights, and having another ſmall Sight at the End thereof, may move juſtly along the ſide of the Index. Then (the Inſtrument ſtanding Horizontal) if you look thro' this ſmall Sight, and by the Pin on which the Label hangeth, move the Label to and fro, till you eſpy the Mark you look at, then will the Label ſhew you what Degree of the Tangent-line is cut thereby. This one Line thus projected upon the ſide of the Rular, performeth all the Uſes of thoſe divided Sights, and is far better, and leſs cumberſome than them or a Quadrant, (ſuch as I formerly deſcribed in *Planometria*) becauſe the Degrees are larger. This line of Tangents is projected on the Index from the foot of the farthermoſt Sight, all along the Rular, to the foot of the nethermoſt Sight, and up the ſide thereof, and is numbered from 1 to 90, by 10, 20, 30, 40, 50, *&c.* ending at the foot of the farthermoſt Sight, from whence the line proceeded.

The uſe of this line of Tangents, in taking of Heights, is ſhewed in the fourth Book, and uſed with the Tables of Sines and Logarithms, treated of in the third Book; without which Tables, (or ſomething equivalent thereunto) this Line of Tangents will be of little Uſe. Therefore it will be convenient to have upon the Index of your Table, the Lines of Artificial Numbers, Sines and Tangents, by which you may work any proportion required very ſpeedily and exactly; ſo that if you are deſtitute of your Tables, theſe Lines will ſufficiently help you.

Now, when I come to ſhew you the Uſe of this Line of Tangents, with the Tables of Sines and Logarithms in the reſolving of Triangles, I will alſo ſhew you how to perform the ſame Propoſitions

poſitions by the Lines of Artificial Numbers, Sines and Tangents: And thefore I would adviſe every Man to have theſe ſo neceſſary Lines upon his Index alſo, and the Numbers and Sines back to back, on the ſame common Line.

Fourthly, Unto this Inſtrument alſo belongeth a Box and Needle, which is to be faſten'd to the ſide of the Table, by help of two Screws; ſo that it may be taken off and put on at pleaſure. In the bottom of this Box muſt be placed a Card, divided into 360 Degrees, number'd (if you pleaſe) after the uſual manner, from the North Eaſtward: But the Card, by which all the Examples in this Book were framed, was number'd from the North Weſtward, by 10, 20, 30, *&c.* to 360, contrary to the common Cuſtom. But the beſt way of numbering will be from the North and South, towards the Eaſt and Weſt, by 10, 20, 30, *&c.* to 90, at the Eaſt and Weſt Points.

There belongeth alſo to this Inſtrument, a Socket of Braſs, to be ſcrewed on the back-ſide of the Table, into which muſt be put the Head of the three-legg'd Staff. This Staff ought to be joined in the middle, ſo that it may be the more portable. For the Socket it may be a plain one, or rather a Ball-ſocket; for by help thereof, you may place the Table (or any other Inſtrument) either Horizontal, Vertical, or in any other Poſition, without altering to Legs of your Staff when once ſet.

¶ *Note*, That the Inſtrument, (if made according to theſe Directions) is the moſt abſolute Inſtrument for a Surveyor to uſe; a ſmall Figure whereof, all the Parts thereof being put together, may be ſeen in the Diagram or Scheme, at the end of this Second Book annexed.

CHAP. VII.

Of Chains, *the ſeveral Sorts thereof.*

OF Chains there are divers ſorts; as namely, Foot-Chains, each Link containing a Foot or 12 Inches, and ſo the whole Pole or Perch will contain 16½ Links or Feet, anſwering to the Statute Denomination.

Some Chains have each Pole divided into ten equal Parts, and theſe are called Decimal Chains: And this groſs Diviſion may be convenient in ſome Practices.

The Chains now uſed, and moſt eſteemed by Surveyors, are eſpecially two: Namely, that generally uſed by Mr. *Rathborn*, which hath every Perch divided into 100 Links; and that of M. r*Gunter*, which hath four Poles divided into 100 Links; ſo that

that each Link of Mr. *Gunter*'s Chain is as long as four of Mr. *Rathborn*'s; and 50 Links of this Chain is two Pole, 25 one Pole, and 75 three Pole.

Now, becauſe theſe Chains are moſt eſteemed of and uſed by Surveyors, I will therefore make a general Deſcription of them both, leaving every Man at liberty to take his choice.

I. Of Mr. *Rathborn*'s Chain.

THE Chain which Mr. *Rathborn* ordinarily uſed (as himſelf ſaith) contained in length two Statute Poles or Perches, each Pole containing in length 16½ Feet, which is 198 Inches: Then each Pole was divided into 10 equal parts, called *Primes*, every of which contained in length 19⅘ Inches. Again, every of thoſe *Primes* was ſubdivided into 10 other equal parts, called *Seconds*; ſo that every of theſe *Seconds* contained in length 1$\frac{49}{50}$ Inches; ſo that the Pole, Perch, Unite, or Commencement (as he calleth it) was divided into 100 equal parts or Links, called *Seconds*.

This Chain being thus divided and marked, you have every whole Pole equal to ten *Primes*, or 100 *Seconds*; every three-quarters of a pole equal to ſeven *Primes* and an half, or 75 *Seconds*; every half Pole equal to five *Primes*, or 50 *Seconds*; and laſtly every quarter of a Pole equal to two *Primes* and a half, or 95 *Seconds*.

II. Of Mr. *Gunter*'s Chain.

AS every Pole of Mr. *Rathborn*'s Chain was divided into 100 Links, ſo Mr. *Gunter*'s whole Chain (which is always made to contain four Poles) is divided into 100 Links, one of theſe Links being four times the length of the other. Now, if this Chain be made according to the Statute, each Perch to contain 16½ Feet; then each Link of this Chain will contain 7 Inches, and $\frac{92}{100}$ of an Inch, and the whole Chain 792 Inches, or 66 Feet.

In meaſuring with this Chain, you are to take notice only of Chains and Links, as ſaying, ſuch a line meaſured by the Chain, contains 72 Chains 48 Links; which you may expreſs more briefly thus, 72, 48. And theſe are all the Denominations which are neceſſary to be taken notice of in ſurveying of Land.

For the ready counting of the Links of this Chain, there ought to be theſe Diſtinctions; namely, in the middle thereof, which is at two Poles end, let there be hanged a large Ring, ſo is the whole Chain by this divided into two equal Parts.

Secondly, Let each of theſe two parts be divided into two other equal parts, by two other the like Rings; ſo ſhall the whole Chain be divided into four equal Parts or Perches, each Perch containing 25 Links.

Thirdly, At every ten Links let be faſten'd a leſſer Ring than the former: And laſtly, at every fifth Link, (if you pleaſe) may be faſten'd other Marks: So by this means you ſhall moſt eaſily and exactly count the Links of your Chain without any trouble. The Chain being thus diſtinguiſhed, it mattereth not which End thereof be carried forward, becauſe the Notes of diſtinction proceed alike on both ſides from the middle of the Chain. But it is very convenient, and I always uſe it, to tie at my middle Ring a good large Rag of ſome light-colour'd Cloth, and at the two other great Rings, two other leſſer Rags of ſome other Colour; for in long Graſs, or the like, the Rings are not to be ſeen: And a great Advantage you'll find in your counting, by means of theſe Rags.

¶ Here *Note*, That in the Examples in this Book, the Lines are ſuppoſed to be meaſured by this four-Pole Chain of Mr. *Gunter*, it being the beſt of any other. The manner how to caſt up the content of any Plot meaſured therewith, ſhall be hereafter taught in its due place.

Cautions to be obſerved in the uſe of any Chain.

IN meaſuring a large Diſtance with your Chain, you may caſually miſtake or miſs a Chain or two in keeping your Account, from whence will enſue a conſiderable Error: Alſo in meaſuring of Diſtances, (when you go not along a Hedge ſide) you can hardly keep your Inſtrument, Chain, or Mark, in a right line, which if you do not, muſt neceſſarily make your meaſured Diſtance greater than in reality it is. For the avoiding either of theſe Miſtakes, you ought to provide ten ſmall Sticks or Arrows, which let him that leadeth the Chain, carry in his Hand before, and at the end of every Chain ſtick one of theſe Arrows into the Ground, which let him that followeth the Chain take up, ſo going on till the whole number of Arrows be ſpent; and then you may conclude that you have meaſured ten Chains, without any farther trouble: And theſe ten Chains (if the Diſtance you are to meaſure be large) you may call a *Change*; and ſo you may denominate every large Diſtance by *Changes*, *Chains*, and *Links*. Or you may, at the end of every ten Chains, ſet up another kind of Stick, by which (ſtanding at the Inſtrument) you may ſee whether your Eye, the Stick, and the Mark to which you are to meaſure, be in the right line or not, and accordingly guide thoſe that carry the Chain, with the more exactneſs to direct it to the Mark intended. And, that

that no Miſtakes may be made by thoſe that carry the Chain, let them be made to underſtand (or look thereafter your ſelf) the following Directions.

Directions for thoſe that carry the Chain.

LET the former Man which leads the *Chain*, beſure to lead ſtrait in a line from the Place where he that hath the other end of the *Chain* begins to meaſure, and the Work to which you are to meaſure, which for his Guide herein he hath theſe Helps: Suppoſe you were to meaſure from A to B. Let the hindermoſt Man ſtanding at A, guide the foremoſt right in a Line to B; and at the firſt *Chain*'s length, let the foremoſt prick down a Stick (or Wire) to which, when the hindermoſt cometh, let him take up: And all the way afterwards, let the hindermoſt guide the foremoſt, and the foremoſt the hindermoſt: For, if the hindermoſt ſee the foremoſt right in a Line between him and B, and the foremoſt ſee the hindermoſt in a right Line between him and A, then are they both in the right Line between A and B: Then, to go forward, let the fore-man take all the Ten Sticks, and tell them at the beginning and ending of every *Change*, (for the moſt common Miſtake is, the looſing, or miſs-telling of a Stick or Wire) and carry all of them, ſave one, in his left-Hand, and that one, and the *Chain*'s end in his right-Hand; and let him go on in a ſtrait line towards B, not looking behind him, till he feel the Chain check him; then ſtick down that Stick, and away as faſt as you can; and as you go, ſhift another Stick, or Wire, into your right-Hand, to be ready to ſtick down at the *Chain*'s end; in the mean time the hinder-Man holding the Chain in his Right-hand; let him look that it be not tangled, and go on till he come to the next Stick, and then clapping the end of the *Chain* to the Stick, let him take it up with the ſame Hand that he holds the *Chain* with, and away after his Leader: And when all the Ten Sticks are run out, and you are not yet at the end of that Station (that is, not come to B,) let the fore-Man run one *Chain* more, holding ſtill the Ring in his Hand, and at the end thereof ſet his Toe, there ſtanding ſtill, and let the hinder-Man take up the tenth Stick, and hold that in one Hand, and the other nine in the other, and deliver the nine to the Fore-man, ſetting his Toe to the Fore-man's, and let the Fore-man count the Nine; and if they be right away forward, but if they be not, you muſt meaſure that Length again, and ſeek the Stick, for you know not which of you loſt it; and thus go on to the End.

How

How to reduce any number of Chains *and* Links *into* Feet.

IN the practice of many Geometrical Concluſions, as in the taking of Heights and Diſtances hereafter taught: As alſo in the meaſuring of Tofts of Ground, Ground-plots of Houſes, Yards, Gardens, *&c.* it is requiſite to give your Meaſure (in ſuch Caſes) in Feet or Yards, and not in Poles or Perches: Yet becauſe your Chain is the moſt neceſſary Inſtrument to meaſure withal, I thought it convenient in this Place to ſhew you how to reduce any number of Chains and Links into Feet, which is thus.

Multiply your number of Chains and Links together as one whole Number, by 66, cutting off from the product the two laſt Figures towards the Right-hand, ſo ſhall the reſt of the product be Feet, and the two Figures cut off ſhall be hundred parts of a Foot.

EXAMPLE.

Let it be required to know how many Feet are contained in five Chains, 32 Links. Firſt, ſet down your five Chains 32 Links, as is before taught, and as you ſee in the firſt Example, with a Comma between the Chains and Links: Then multiplying the five Chains, 32 Links, by 66, the Product will be 35112, from which, cut off the two laſt Figures towards the Right-hand, with a Comma, then will the Number be 351, 12. which is 351 Feet, and $\frac{12}{100}$ parts of a Foot, or 351 Feet, one Inch and a half; and ſo many Feet are contained in five Chains, 32 Links.

Example I.	*Example II.*
5,32	9,05
66	66
3192	5430
3192	5430
351,12	597,30

But let the number of Chains be what they will, if the number of Links be leſs than 10, as in the ſecond Example it is 9 Chains, 5 Links, you muſt place a Cypher before the 5 Links, as there you ſee, and then multiplying that Number (*viz.* 9, 05) by 66, the Product will be 59730, from which taking the two laſt Figures, there will remain 597 Feet, and $\frac{30}{100}$ parts of a Foot, which is 595 Feet, one quarter, and half of an Inch. The like may be done for any other number of Chains and Links whatſoever.

According to theſe Examples is made the Table following, which ſheweth how many Feet are contained in any number of Chains and Links, from five Links to eight Chains, for every fifth Link, which is ſufficient for ordinary Uſe. By which Table you may ſee, that in 6 Chains 40 Links, is contained 422 Feet, and $\frac{40}{100}$ parts of a Foot: Alſo in five Chains 55 Links, is contained 366 Feet, and $\frac{20}{100}$ parts of a Foot: And ſo of any other.

A TABLE ſhewing how many Feet and parts of a Foot, are contain'd in any number of Chains and Links, between five Links and eight Chains.

	0	1	2	3	4	5	6	7
0		66,00	132,00	198,00	264,00	330,00	396,00	462,00
6	3,30	96,30	135,30	201,30	267,30	333,30	399,30	399,30
10	6,60	72,60	138,60	204,60	270,60	336,60	402,60	468,60
15	9,90	75,90	141,90	207,90	273,90	339,90	405,90	471,90
20	13,20	79,20	145,20	211,20	277,20	343,20	409,20	475,20
25	16,50	82,50	148,50	214,50	280,50	346,50	412,50	478,50
30	19,80	85,80	151,80	217,80	283,80	349,80	415,80	481,80
35	23,10	89,10	155,10	221,10	287,10	353,10	419,10	485,10
40	26,40	92,40	158,40	224,40	290,40	356,40	422,40	488,40
45	29,70	95,70	161,70	227,70	293,70	359,70	425,70	491,70
50	33,00	99,00	165,00	231,00	297,00	363,00	429,00	495,00
55	36,30	102,30	168,30	234,30	300,30	366,30	432,30	498,30
60	39,60	105,60	171,60	237,60	303,60	369,60	435,60	501,60
65	42,90	108,90	174,90	240,90	306,90	372,90	38,90	504,90
70	46,20	112,20	178,20	244,20	310,20	376,20	442,20	508,20
75	49,50	115,50	181,50	247,50	313,50	379,50	445,50	511,50
80	52,80	118,80	884,80	250,10	316,80	382,80	448,80	514,80
85	56,10	122,10	188,10	254,10	320,10	386,10	452,10	518,10
90	59,40	125,40	191,40	257,40	323,40	389,40	455,40	521,40
95	62,70	128,70	194,70	260,70	326,70	392,70	458,70	524,70

To this Table I will add this uſeful and neceſſary Table of Mr. *Gunter*'s enlarged, which ſheweth how many ſquare Inches, Feet, Yards, Paces, Chains, *&c.* are contained in a ſquare Acre of Land.

Length in

Square:	Inch	Links	Feet	Yards	Pace	Perch	Cha	Acre	Mile
Inch.	1	7.92	12	36	60	198	792	7920	63360
Links	62.726	1	1.515	4.56	7.575	25	100	1000	8000
Feet	144	2.295	1	3	5	16.5	66	660	5280
Yard	1296	20.755	9	1	1.66	5.50	22	220	1760
Pace	3600	57.381	25	2.778	1	3.3.	13.2	132	1056
Perch	39204	625	272.25	30.25	10.89	1.	4	40	320
Chain	627264	10000	4356	484	174.24	16	1	10	80
Acre	6272640	10000	43560	4840	1742.4	160	10	1	8
Mile	40144896000	64000000	27878400	3097600	1115136	102400	6400	640	1

By this TABLE you may plainly diſcover, that

In one ſquare Acre there are contained	627264	Inches	Square	And in a ſquare Mile	401448960	Inc.
	100000	Links			64000000	Lin.
	43560	Feet			27878400	Feet.
	4840	Yards			3097600	Yar.
	1742.4	Paces			1115136	Pac.
	160	Perch			102400	Perc.
	10	Chain			6400	Cha.
	1	Acre.			640	Acr.

CHAP. VIII.

Of Protractors.

(Fig. 1.)

A *Protractor* is an Inſtrument by which you are to protract or lay down upon Paper, Parchment, Velom, or the like, the true ſymmetry or proportion of any Field, having made obſervation of the Sides and Angles thereof, by ſome of the Inſtruments before deſcribed.

I. *Of the Common* Protractor.

THis Inſtrument conſiſteth of two parts; the one is a Semicircle divided into Degrees as is the Frame of the Table; and the other is a Scale divided into equal parts; the Semi-circle being to lay down the Angles, and the Scale to plot the Sides. This Inſtrument ought to be made of a piece of thin Braſs well poliſhed, The edges thereof being very ſmooth, and the Scale thereof, namely, the right-angled Parallelogram, or long Square, containing in length from A to B, about four Inches and three quarters, and in breadth from A to C, about one and a half. Let the two ends of the Scale, namely, the ſides A C, and B D, be divided into equal parts of 16 or 20 in an Inch; and let the ſide C D be divided according to a Scale of 10 or 12 in an Inch, or what other number you pleaſe.

The Scale being thus divided, on the middle of the line A B, as at H, deſcribe the Semi-circle E G F, which divide into two Quadrants in the point G, by the help of the perpendicular H G; then divide each of thoſe Quadrants into 90 equal parts, called Degrees; ſo ſhall the whole Semi-circle contain 180 Degrees, which muſt be num-

number'd by 10,20,30, 40, *&c.* to 180, from E by G to F; and the ſame way alſo from 180 to 360, as you ſee done in the Figure; the numbers of the firſt Semi-circle from 00 to 180, being for the Eaſt-ſide of the *Protractor*, and the other numbers from 180, to 360, for the Wed-ſide.

Now you are to note, that the line A B, always repreſenteth the Meridian line, and is ſometimes noted with the Letters S and N, for South and North: but then it is neceſſary that the *Protractor* be divided on either ſide the Plate, which this double numbering avoideth; for the line A B being taken for the Meridian in general, the Semi-circle of the *Protractor* may be turned any way, (either upward or downward) and ſo one Semi-circle being divided will be ſufficient. Yet if any Man be deſirous, he may have it made according to his own Fancy: But this manner of numbring (in my Opinion) is the beſt, it being moſt agreeable to your Inſtruments. But if you uſe the *Circumferentor*, *Theodolite*, or *Perambulator*, your *Protractor* were beſt to be a whole Circle, numbered like to your Inſtrument. And this numbring you are to take particular care of when you buy.

II. *Of a Square* Protractor.

(Fig. 2.)

THE *Protractor* conſiſteth of a piece of thin Braſs, in form of a rectangled *Parallelogram*, upon which, at the diſtance of half an Inch, draw the line E F, parallel to C D; which line divide into two equal parts in the point G, for the Center: From which Center, let the ſides E A, A B, and B F, be divided by lines iſſuing from the Center G, into 180 Degrees, and numbred by 10, 20, 30. 40, *&c.* to 180; and back again from 180, to 360, in all reſpects as the Semi-circle in the other *Protractor* was numbered.

¶ Now, becauſe that in protracting (many times) the Parallels will fall off your Paper or Parchment, ſo that you muſt add a piece thereto for the preſent, there is in the *Protractor*, the Parallelogram I M O L, cut quite out, that you may ſee your Work through; and either ſide of the narrow ſlip of Braſs which is cut out, namely, I L and M O, muſt be divided into the ſame parts with the ſides E A and B F, by a Rular laid from ſide to ſide; and theſe two ſides muſt be numbred by 10, 20, 30, *&c.* as far as they will extend.

To this *Protractor* (if you pleaſe) you may have added upon the edge C D, a Scale of any equal part, as of 10, 12, 20, 24, or 30, in an Inch. The *Protractor* thus made is very convenient for Uſe, and much exceedeth the other before deſcribed.

To

To uſe with your *Protractor* in protracting, you muſt provide a fine Needle, put into a piece of Box or Ivory neatly turned: This will ſerve to fix in your Center, note your Degrees, and other Uſes in drawing your Plot, and is called a protracting Pin.

CHAP. IX.

Of Scales.

(*Fig.* 3.)

FOR the ready laying down of Lines and Angles, according to any aſſigned Quantity, you muſt provide divers Scales. the Scales now ordinarily uſed by Surveyors are principally two: *Firſt*, Of equal parts, for protracting of Lines; and *Secondly*, Of Chords, for the protracting of Angles. Unto theſe may be added, *Thirdly*, A Diagonal Scale, which is (indeed) no other than a Scale of equal parts more ſcrupulouſly divided. If you deſire a convenient Scale, let it be made in this manner, to contain in length about 8 or 9 Incches, and in breadth one inch and a quarter. On one ſide thereof let be placed divers Scales, as of 10, 11, 12, 16, 20, 24, and 30 in an Inch.

¶ Here is to be noted, that when I ſay a Scale of 12 in an Inch, you are to underſtanp a part of a Line divided into 10 equal parts, 12 of which parts would make an Inch; and the like is to be underſtood of any other number of equal parts whatſoever.

On the ſame ſide of the Rular let be placed a line of Chords extended up to 90, and numbred as you ſee in the Figure, by 10, 20, 30, *&c.* to 90. This Scale will be of good Uſe for many purpoſes; as to divide the circumference of a Circle, and to protract Angles in ſome Caſes, better than the *Protractor*.

On the other ſide of the Rular let be drawn a Diagonal Scale, of 10 in an Inch, which will be an excellent Scale for long Plots; out of which you may very well take the hundredth part of an Inch. And this Scale will agree with your Four-pole Chain exceeding well; for, as your whole Chain contains 100 Links, ſo each Inch of this Scale contains 100 parts; ſo that out of it you

you may take any number measured by your Chain, to a Link, and lay it down upon Paper. You may also have half an Inch divided into 100 parts; which Scale will be of good Use also to lay down a smaller Plot.

☞ But if you would have the Scales to be answerable to your Chain, and to agree with the Divisions thereof, then you are to take notice, that

A Scale of	10	Pole in an Inch must be a Scale of	10	in 4 Inches, or	$2\frac{1}{2}$	in one Inch.
	11		11		$2\frac{3}{4}$	
	12		12		3	
	16		16		4	
	20		20		5	
	24		24		6	
	20		30		$7\frac{1}{2}$	

Then will each of those parts represent a Chain; and if you subdivide the last single part into Ten. those parts shall represent Links.

These Scales, also the lines of Numbers, Signs, and Tangents, and reducing Scale hereafter mentioned, may very conveniently be placed on the Index of the *Plain Table*.

To use with this Scale, you must provide a pair of neat Compasses of Brass, with Steel points, filed very small; and also a neat pair of Compasses with three points, and Screws to alter the points, so that you may draw Lines or Circles with black Lead, or any colour'd Ink; which will be very necessary and convenient in beautifying of your Plots after Protraction.

CHAP. X.

Of several sorts of Cards, *and their Divisions.*

Fig. IV.

THE Card which I have always used in all the Examples in the Fourth Book, is that which is reprepresented by the outmost Circle of Numbers, where the numbers of Degrees are continued from 1, to 360, numbered by 10, 20, 30, 40, *&c.* to 360. and this is a good and general Account.

For the *Circumferentor*, because those Instruments are (oftentimes) made small, and the *Cards* in them therefore but little, they use to divide those *Cards* but into 120 Parts or Degrees, each part of them containing three Degrees. And this is represented in the Figure by the innermost Circle of Numbers and Divisions, from 1, to 120.

For the manner of Surveying by way of Traverſe, which is an excellent way for large Grounds, as Parks, Foreſts, Chaſes, &c. (and indeed for whole Countries) there the Account were beſt to be kept by the *bearing* and *diſtance* of Places; wich way of Surveying is ſhewed at large in the *Fourth Book.* Then it were beſt to have the *Card* of your Inſtrument divided into four quarters, divided each into 90 Degrees, and numbred from the North and South, towards the Eaſt and Weſt, by 10, 20, 30, &c. to 90 Degrees, 00 Degrees ſtanding at the North and South points, and 90 Degrees at the Eaſt and Weſt points, and then will the four quarters of the *Card* be thus denominated, the *North-Eaſt*, *North-Weſt*, *South-Eaſt*, and *South-Weſt* Quarters. And this diviſion of a *Card* is expreſſed in the Figure by the middlemoſt manner of Numbring and Dividing.

CHAP. XI.

Of a Field-Book.

IT will be ſufficient in this place, only to deſcribe the manner how a *Field-Book* ought to be Ruled. Let the Book contain any quantity of Paper, more or leſs, and in what Volume you pleaſe; but a long Folio is the beſt: Let it be ruled towards the left Margin of every Page, with five lines with red Ink, ſo ſhall you have four Columns. In the firſt whereof, you muſt note down the Degrees cut either by the Index on the Frame of the Table, or elſe by the Needle on the *Card* of the *Circumferentor*, or the Degrees of the *Peractor*, at every Angle you obſerve. And the ſecond

The manner how a Field-Book ought to be Ruled.

Degrees.	*Minutes.*	*Chains.*	*Links.*	
326	45	16	87	

Column

Column is to note the Minutes or parts of a Degree. For you are to note, that every Degree on the Frame of the Table, or in the *Card* of the *Circumferentor*, is ſuppoſed to be divided into 60 other parts, called Minutes, which cannot be expreſſed by reaſon of the ſmalneſs of the Inſtruments, and therefore muſt only be eſtimated as your Eye judgeth : Yet if your Inſtrument be large enough, you may have each Degree divided into three equal parts, ſo ſhall every part contain 20 Minutes ; or if every Degree be divided into four parts, each part will contain 15 Minutes. The other two Columns ſerve to note down the lengths meaſured by your Chain, as the Chains and Links.

Now ſuppoſe, that making any obſervation in the Field, either with the Degrees on the Frame of the Table, or with the *Circumferentor*, and that obſerving any Angle, (as is hereafter taught) you find the Index of the plain Table, or the Needle in the *Circumferentor*, to cut 326 Degrees, 45 Minutes; theſe 326 Degrees muſt be ſet down in the firſt Column of your *Field-Book*, and the 45 Minutes in the ſecond Column, as you ſee here done. Alſo if you meaſure any length in the Field with your Chain; as ſuppoſe ſome Diſtance meaſured to contain 16 Chains, 87 Links; the 16 Chains muſt be ſet in the third Column, and the 87 Links in the fourth Column, under their reſpective Titles, as you ſee here done.

But if you uſe a Card that hath every Quadrant thereof divided into 90 Degrees, and numbered from *North* to *South*, towards *Eaſt* or *Weſt*, then your four Columns will repreſent the four Quarters of the Card, namely, the *South-Eaſt*, *North-Eaſt*, *South-Weſt*, and *North-Weſt*; and then you may have two other Columns alſo, one for the Degrees and Minutes, the other for the lengths of the Lines: The manner whereof you ſhall ſee in the *Fourth Book*, when we come to ſhew the manner of Surveying by way of Traverſe.

But the laſt broad Column of the *Field-Book* here deſcribed, is to take notice of Objects as you paſs along, that ſo you may expreſs them in your Plot in their due Places ; as any Houſe, Windmill, Water-mill, eminent Tree for directing the Road, or ſuch-like: Alſo to write the Names of the Cloſes, or other Crounds butting and bounding upon that Survey : Likewiſe to make Marks, when you leave one Field and go to another, to know where to begin to Protract; with many other things which will fall in your way in Practice, which ſhall be explained in the *Fourth Book*, where the Uſe of the *Field-Book* is exemplified at large.

CHAP.

CHAP. XII.

Of Inſtruments for reducing of Plots.

FOR the reducing of Plots from one Form to another, there have been divers Inſtruments invented. One that performeth that Work very well, is a Rular having certain proportional Scales thereupon, with a ſliding Vein of Braſs to move from End to End thereof. This Inſtrument well made, and the Lines thereof fitted to your proportion, will be very eaſy and exact. The manner of uſing it, and the way of proportioning of it, ſhall be ſhewed hereafter. This Inſtrument, tho' it be not general, yet it may be fitted to five or ſix ſeveral proportions, which for that purpoſe is ſufficient.

Another Inſtrument for the performance of the Work, is a Parallelogram, the making whereof is well known to the Inſtrument-maker. It is general, exact, and of quick Diſpatch: All the difficulty is in the neat handling of it, which you will find ſomewhat difficult.

The End of the Second Book.

The

Fig. I.

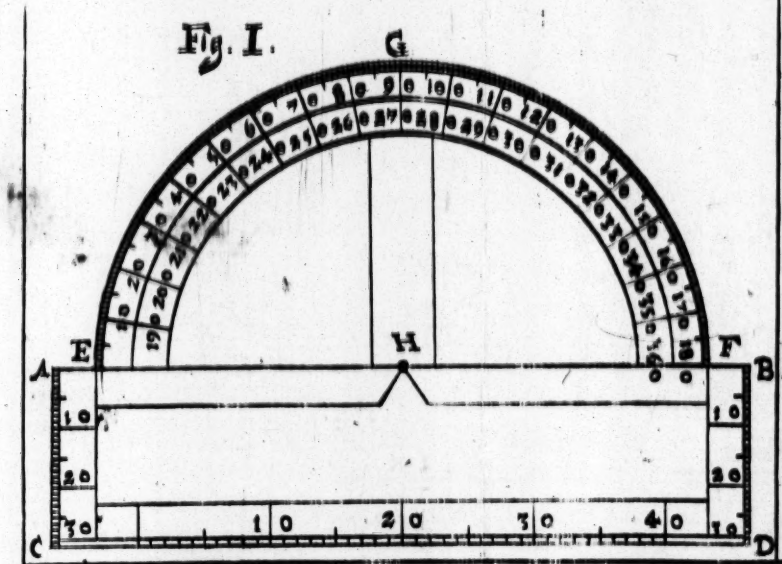


Fig. II.

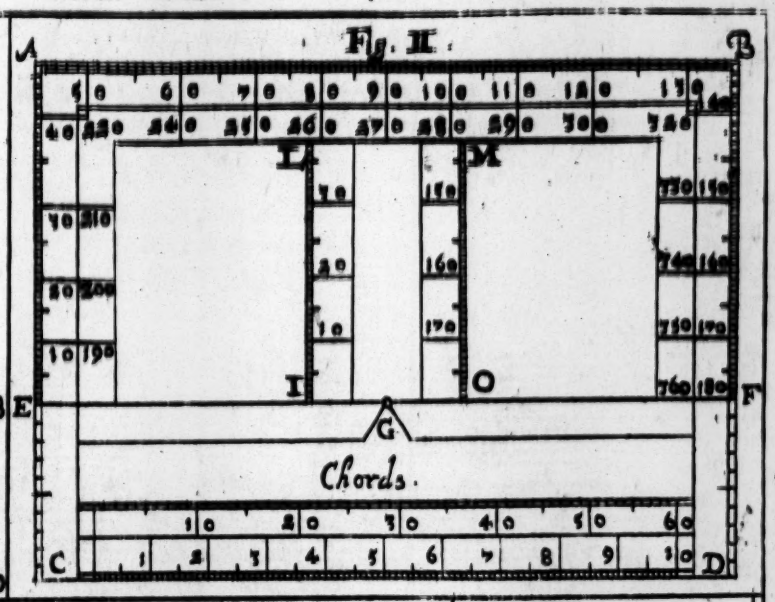


Fig. III.

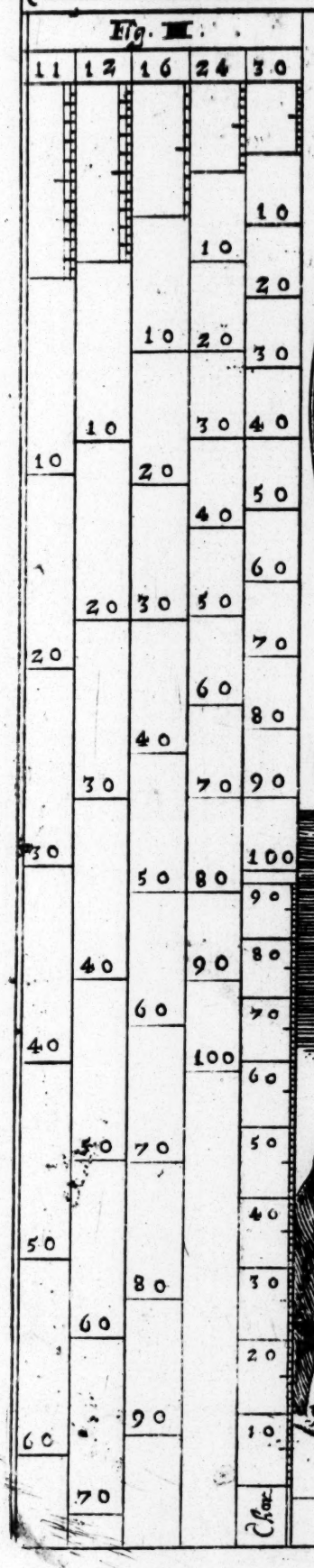


Fig. IV.

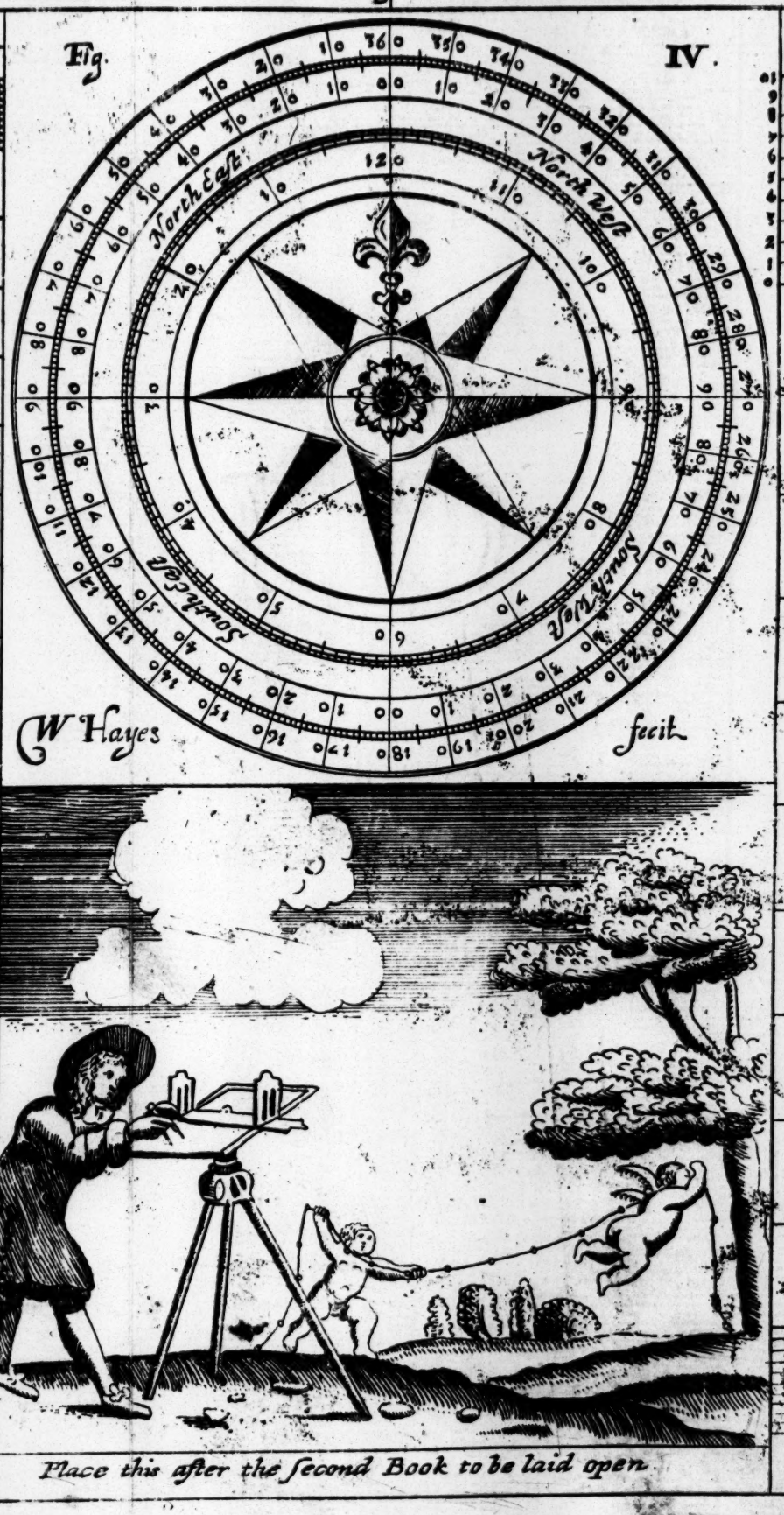
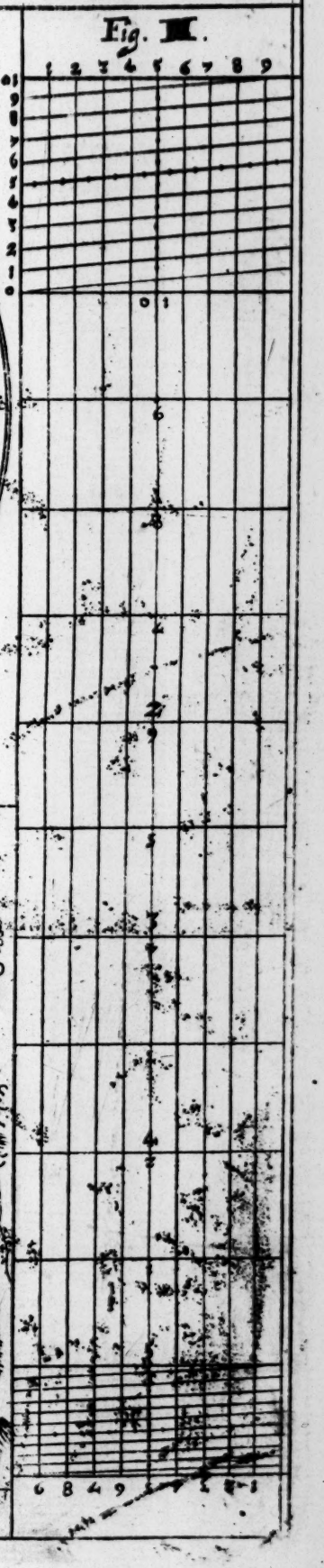


Fig. V.



Place this after the second Book to be laid open

The COMPLEAT SURVEYOR.

The Third Book.

In Two Parts.

The ARGUMENT.

THIS Third Book *is as it were a* Key *to thoſe that follow, the* Subject *whereof is principally* Trigonometry, *or the meaſuring of* Triangles. *Now, foraſmuch as the* Art *of meaſuring* Heights *and* Diſtances, *and* plotting *and* protracting *of* Land, *and all ſuch-like lineal and ſuperficial Dimenſions, is grounded upon the reſolution of* Plain Triangles, *I hold it convenient (before I come to the practice of* Surveying, *or to ſhew the Uſe of any* Inſtrument *in taking of* Heights *and* Diſtances) *to ſay ſomething concerning* Plain Triangles, *(at leaſt, ſo much as is neceſſary for a* Surveyor *to know) although that*

Subject *be handled at large by divers able* Mathematicians *already, whose* Works *are extant, viz.* Pitiscus, Snelius, *the Lord* Napier, *Mr.* Gunter, *Mr.* Norwood, *Mr.* Gellibrand, *&c. Of which* Subject *I shall shortly have a* Treatise *extant, shewing the resolution of* Triangles *both* Plain *and* Spherical, *with the Application there-of in the practical parts of the* Mathematicks, *as in* Geometry, Astronomy, Navigation, Dialling, Fortification, *&c. Now, because the readiest way of resolving* Triangles, *is by* Sines, Tangents, *and* Logarithms; *I have therefore added brief* Tables *for that purpose; viz. A* Table *of* Sines *and* Tangents *to every tenth* minute *of the* Quadrant, *and a* Tale *of* Logarithms, *from* 1, *to* 1000. *By which* Tables *may be resolved all* Cases *both in* Right-lined *and* Spherical Triangles. *But in this Place I have made choice only of such* Cases, *and other useful* Problems, *which are of most frequent use in the Practice of* Surveying, *omitting divers others to which these* Tables *are subservient. And of such as I have choice of (in respect of the brevity of the* Tables) *I have shewed how they may also be performed by the* Lines *of* Artificial Numbers, Sines, *and* Tangents, *before spoken of in the description of the* Index *of the* Plain Table *in the last* Book; *and therefore a* Surveyor *ought in no wise to be without them, but ought always, when he is employed in* Surveying, *to have either these* Lines *or the* Tables *at hand.*

OF

OF

TRIGONOMETRY.

The First PART.

Shewing the Uſe of the Tables, and *Lines* of *Artificial Sines, Tangents*, and *Logarithms*, in the Solution or Dimenſion of *Plain Triangles*, and in other uſeful Problems pertinent to the Art of *Surveying*.

CHAP. I.

The Explanation and Uſe of the Table of SINES.

BEfore I come to the menſuration of Triangles, and to the performance of other uſeful and neceſſary Problems in the Art of Surveying, it will be neceſſary to explain and ſhew the Uſe of the Tables of *Sines*, *Tangents*, and *Logarithms* following; by by which Tables, the ſides or angles of right-lined Triangles, may be readily and exactly meaſured; ſo that in any plain Triangle, if there be any three parts thereof given, a fourth may be eaſily diſcovered.

The

The Table of *Sines* and *Tangents*, conſiſteth of twice three Rows or Columns; the firſt whereof ſheweth the Degrees and Minutes of the Quadrant, having over the Head thereof theſe two Letters, *D. M.* ſtanding for *Degrees* and *Minutes*. In the ſecond and third Columns, are the Artificial *Sines* and *Tangents*, anſwering to every Degree and 10th Minute of the Quadrant, having the word *Sine* over the Head of the *Sines*, and the word *Tangent* over the Head of the *Tangents*. The Uſe of which Table will appear by the folloing *Propoſitions*.

PROP. I.

Any Degree and Minute being given, to find the Sine *or* Tangent *thereof.*

FIrſt ſeek the Degree and Minute you deſire the Sine or Tangent of, under *D. M.* the Degrees under the Letter *D.* and the Minutes under the letter *M.* and right againſt it, in the next Column towards the right Hand, under the word *Sine*, or *Tangent*, you ſhall have your Deſire.

EXAMPLE I.

Suppoſe it were required to find the Sine and Tangent of 20 Degrees. Firſt, You muſt ſeek 20 in the firſt Column of the Table under *D. M.* and right againſt 20, in the ſecond Column, under the word *Sine*, you ſhall find 9, 534052, which is the Sine of 20 Degrees: And in the next Column under Tangent, you ſhall find 9, 56107, which is the Tangent of 20 Degrees.

In the ſame manner you ſhall find the Sine of 50 Degrees, to be 9, 884254, and the Sine of 76 Degrees to be 9, 986904; And the Tangent of 50 deg. to be 10, 07619; and the Tangent of 76 deg. to be 10, 60323.

EXAMPLE II.

Let it be required to find the Sine and Tangent of 40 degrees 30 minutes. Firſt you muſt find 40, 30 (which is 40 degrees 30 minutes) in the firſt Column, under the letters *D. M.* that is, 40 under *D.* and 30 under *M.* and againſt it you ſhall find 9, 812544, which is the Sine; and 9, 93150, which is the Tangent of 40 degrees 30 minutes.

Alſo

Alſo the Sign of 62 degrees 10 minutes, will be found to be 9, 946604; and the Tangent 10,27738. and the Sine of 86 degrees 30 minutes, will be 9, 999189. and the Tangent 11,21351. And in this manner may you find the artificial Sine and Tangent of any Number of degrees and minutes expreſſed in the Table.

PROP. II.

Any Sine *or* Tangent *being given to find the number of Degrees and Minutes thereunto belonging.*

EXAMPLE.

LET 9, 866470 be a Sine given, and let it be required to find the degree and minute of the Quadrant anſwering thereunto. Firſt ſeek in the ſecond amongſt the Sines, for 9, 866470, and againſt it (on the left Hand) you ſhall find 47 degrees 20 minutes, which is the Arch of the Quadrant anſwering thereunto.

Again, let it be required to find the Arch anſwering to this Sine 9, 821264. Having found 9, 821264 in the Second Column under the word *Sine*, againſt it you ſhall find 41 degrees 30 minutes, and that is the arch or degree belonging thereto.

Alſo, if the Tangent 9.60641 were given, the Degrees and minutes will be found to be 22 degrees: And 10.47969, will be found to be the Tangent of 71 deg. 40 min.

¶ But in caſe you have a number given which you cannot exactly find in the Table, you muſt then, inſtead thereof take the neareſt in the Table: As if your Number given were 9, 675859, if you look in the Table of Sines for this Number, it cannot be found there; but the neareſt thereunto is 9, 676328, which is the Sine of 28 degree, 20 minutes, which you muſt take inſtead thereof. But theſe Tables being only to every tenth minute, are of ſufficient extent for any thing belonging to Surveying. Thoſe that deſire more exactneſs, muſt repair to ſuch Books which have theſe Tables at large, of which there are divers in ſeveral Volumes eaſie to be had.

The TABLE of *Sines* and *Tangents*.

D. M.	Sines.	Tang.	D. M.	Sines.	Tang.	D. M.	Sines.	Tang.
			8 0	9,143555	9,14780	16 0	9,440338	9,45750
10	7,463726	7,46373	10	9,152451	9,15688	10	9,444720	9,46224
20	7,764754	7,76476	20	9,161164	9,16577	20	9,449054	9,46694
30	7,940842	7,94084	30	9,169702	9,17450	30	9,453342	9,47160
40	8,065776	8,06581	40	9,178072	9,18306	40	9,457584	9,47622
50	8,162681	8,16274	50	9,186280	9,19146	50	9,461782	9,48080
1 0	8,241855	9,24192	9 0	9,194332	9,19971	17 0	9,465935	9,48534
10	8,308794	8,30888	10	9,202234	9,20782	10	9,466446	9,48984
20	8,366777	8,36690	20	9,209992	9,21578	20	9,474115	9,49430
30	8,417919	8,41087	30	9,217609	9,22361	30	9,478142	9,49872
40	8,463665	8,46385	40	9,225092	9,23130	40	9,482128	9,50311
50	8,505045	8,50527	50	9,232444	9,23887	50	9,486055	9,50746
2 0	8,542819	8,54308	10 0	9,239670	9,24632	18 0	9,489982	9,51178
10	8,577566	8,57788	10	9,246795	9,25365	10	9,493851	9,51606
20	8,609734	8,61010	20	9,253761	9,26086	20	9,497682	9,52030
30	8,639679	8,64009	30	9,260633	9,26797	30	9,501476	9,52452
40	8,667689	8,66816	40	9,267395	9,27496	40	9,505234	9,52870
50	8,693998	8,69453	50	9,274049	9,28186	50	9,508955	9,53285
3 0	8,718800	8,71940	11 0	9,280599	9,28865	19 0	9,512642	9,53697
10	8,742259	8,74292	10	9,287048	9,29535	10	9,516294	9,54106
20	8,764511	8,76525	20	9,293399	9,30195	20	9,519911	9,54512
30	8,785675	8,78649	30	9,299655	9,30846	30	9,523495	9,54915
40	8,805852	8,80674	40	9,305819	9,31488	40	9,527046	9,55315
50	8,825130	8,82610	50	9,311899	9,32122	50	9,530565	9,55712
4 0	8,843584	8,84464	12 0	9,317879	9,32747	20 0	9,534052	9,56107
10	8,861283	8,86243	10	9,323780	9,33365	10	9,537507	9,56498
20	8,878285	8,87952	20	9,329599	9,33974	20	9,540931	9,56887
30	8,894643	8,89508	30	9,335337	9,34575	30	9,544325	9,57274
40	8,910404	8,91185	40	9,340996	9,35170	40	9,547689	9,57658
50	8,925609	8,92716	50	9,346579	9,35757	50	9,551024	9,58039
5 0	8,940296	8,94195	13 0	9,352088	9,36336	21 0	9,554329	9,58418
10	8,954499	8,95627	10	9,357524	9,36909	10	9,557606	9,58794
20	8,968249	8,97013	20	9,362889	9,37476	20	9,560855	9,59168
30	8,981573	8,98358	30	9,368185	9,38035	30	9,564075	9,59540
40	8,994497	8,99622	40	9,373414	9,38589	40	9,567269	9,59909
50	9,007044	9,00930	50	9,378577	9,39136	50	9,570435	9,60276
6 0	9,019235	9,02162	14 0	9,383675	9,39677	22 0	9,573575	9,60641
10	9,031089	9,03361	10	9,388711	9,40212	10	9,576689	9,61004
20	9,042625	9,04528	20	9,393685	9,40742	20	9,579777	9,61364
30	9,053859	9,05666	30	9,398600	9,42666	30	9,582840	9,61722
40	9,064806	9,06775	40	9,403455	9,41784	40	9,585877	9,62079
50	9,075480	9,07858	50	9,408254	9,42297	50	9,588890	9,62433
7 0	9,085894	9,08914	15 0	9,412996	9,42805	23 0	9,591878	9,62785
10	9,096062	9,09947	10	9,417684	9,43308	10	9,594842	9,63135
20	9,105992	9,10956	20	9,422317	9,43046	20	9,597783	9,63484
30	9,115698	9,11943	30	9,426895	9,44299	30	9,600700	9,63830
40	9,125187	9,12909	40	9,431429	9,44787	40	9,603594	9,64175
50	9,134470	9,13854	50	9,435918	9,45271	50	9,606465	9,64517

The TABLE of *Sines* and *Tangents.*

D. M.	Sines.	Tang.	D. M.	Sines.	Tang.	D. M.	Sines.	Tang.
24 0	9,609313	9,64858	32 0	9,724210	9,795794	40 0	9,808067	9,92381
10	9,612148	9,65197	10	9,726225	9,79860	10	9,809569	9,92638
20	9,614944	9,65535	20	9,728227	9,80140	20	9,810061	9,92894
30	9,617727	9,65870	30	9,730216	9,80419	30	9,812544	9,93150
40	9,620488	9,66204	40	9,732193	9,80697	40	9,814019	9,93406
50	9,623229	9,66536	50	9,734157	9,80975	50	9,815465	9,93661
25 0	9,625948	9,66867	33 0	9,736109	9,812524	1 0	9,816943	9,93916
10	9,628647	9,67196	10	9,738048	9,81528	10	9,818392	9,94171
20	9,631326	9,67524	20	9,739975	9,81803	20	9,819832	9,94426
30	9,633984	9,67859	30	9,741889	9,82078	30	9,821264	9,94681
40	9,636623	9,68154	48	9,743792	9,82352	40	9,822688	9,94935
50	9,639242	9,68497	50	9,745683	9,82626	50	9,824104	9,95190
26 0	9,641842	9,68818	34 0	9,747562	9,821994	2 0	9,825511	9,95444
10	9,644423	9,69138	10	9,749429	9,83171	10	9,826910	9,95698
20	9,646984	9,69457	20	9,751284	9,83442	20	9,828301	9,95952
30	9,649527	9,69774	30	9,753128	9,83713	30	9,829683	9,96205
40	9,652052	9,70089	40	9,754960	9,83984	40	9,831058	9,96459
50	9,654558	9,70404	50	9,756781	9,84253	50	9,832425	9,96712
27 0	9,657047	9,70717	35 0	9,758591	9,845234	3 0	9,833783	9,96966
10	9,659517	9,71028	10	9,760390	9,84791	10	9,835134	9,97218
20	9,661970	9,71329	20	9,762177	9,85059	20	9,836477	9,97472
30	9,664406	9,71648	30	9,763954	9,85327	30	9,837812	9,97725
40	9,666824	9,71950	40	9,765720	9,85594	40	9,839140	9,97978
50	9,669225	9,72260	50	9,767474	9,85860	50	9,840459	9,98231
28 0	9,671609	9,72560	36 0	9,769219	9,861264	4 0	9,841771	9,98484
10	9,673977	9,72870	10	9,770952	9,86391	10	9,843079	9,98736
20	9,676328	9,73170	20	9,772675	9,86656	20	9,844372	9,98989
30	9,678663	9,73470	30	9,774388	9,86925	30	9,845662	9,99242
40	9,680982	9,73777	40	9,776090	9,87185	40	9,846944	9,99405
50	9,683284	9,74077	50	9,777781	9,87448	50	9,848218	9,99743
29 0	9,685571	9,74375	37 0	9,779463	9,877114	5 0	9,849485	10,00000
10	9,687842	9,74673	10	9,781134	9,87974	18	9,850745	10,00253
20	9,690098	9,74969	20	9,782796	9,88236	20	9,851997	10,00505
30	9,692339	9,75264	30	9,784447	9,88498	30	9,853242	10,00758
40	9,694564	9,75558	40	9,786088	9,88759	40	9,854480	10,01011
50	9,696774	9,75852	50	9,787720	9,89020	50	9,855710	10,01264
30 0	9,698970	9,76144	38 0	9,789342	9,892816	0	9,856934	10,01516
10	9,701151	9,76435	10	9,790954	9,89541	10	9,858150	10,01769
20	9,703317	9,76726	20	9,792557	9,89801	20	9,859360	10,02022
30	9,705469	9,77015	30	9,794149	9,90060	30	9,860562	10,02275
40	9,707606	9,77303	40	9,795733	9,90320	40	9,861757	10,02528
50	9,709730	9,77591	50	9,797307	9,90578	50	9,862946	10,02781
31 0	9,711839	9,77877	39 0	9,798872	9,908377	7 0	9,864127	10,03034
10	9,713935	9,78163	10	9,800427	9,91095	10	9,865302	10,03288
20	9,716013	9,78448	20	9,801972	9,91353	20	9,866470	10,03541
10	9,718085	9,78732	30	9,803510	9,91610	30	9,867631	10,03795
48	9,720140	9,79015	40	9,805038	9,91868	40	9,868785	10,04048
50	9,722181	9,79297	50	9,806557	9,92125	50	9,869933	10,04302

The TABLE of *Sines* and *Tangents*.

D. M.	Sines.	Tang.	D. M.	Sines.	Tang.	D. M.	Sines.	Tang.
48 0	9,871073	10,045566	56 0	9,918574	10,171046	64 0	9,953660	10,311826
10	9,872208	10,04810	10	9,919424	10,17374	10	9,954274	10,31503
20	9,873335	10,05065	20	9,920268	10,17648	20	9,954883	10,31826
30	9,874456	10,05319	30	9,921107	10,17922	30	9,955488	10,32150
40	9,875571	10,05574	40	9,921940	10,18196	40	9,956088	10,32476
50	9,876678	10,05829	50	9,922768	10,18412	50	9,956684	10,32804
49 0	9,877780	10,0608457	0	9,923591	10,18748	65 0	9,957276	10,33133
10	9,878875	10,06339	10	9,924409	10,19025	10	9,957862	10,33463
20	9,879963	10,06594	20	9,925222	10,19303	20	9,958445	10,33796
30	9,881045	10,06850	30	9,926029	10,19581	30	9,959023	10,34130
40	9,882121	10,07106	40	9,926831	10,19860	40	9,959596	10,34465
50	9,883191	10,07362	50	9,927628	10,20140	50	9,960165	10,34803
50 0	9,884254	10,0761958	0	9,928420	10,20421	66 0	9,960730	10,35142
10	9,885311	10,07875	10	9,929207	10,20703	10	9,961290	10,35483
20	9,886361	10,08132	10	9,929989	10,26985	20	9,961846	10,35825
30	9,887406	10,08390	30	9,930766	10,21268	30	9,962398	10,36170
40	9,888444	10,08647	40	9,931537	10,21552	40	9,962945	10,36516
50	9,889476	10,08905	50	9,932304	10,21837	50	9,963488	10,36865
51 0	9,890503	10,09163	59 0	9,933066	10,22123	67 0	9,964026	10,37215
10	9,891522	10,09422	10	9,933822	10,22409	10	9,964560	10,37567
20	9,892536	10,09680	20	9,934574	10,22697	20	9,965090	10,37921
30	9,893544	10,09939	30	9,935320	10,22985	30	9,965615	10,38278
40	9,894546	10,10199	40	9,936062	10,23278	40	9,966136	10,38636
50	9,895542	10,10459	50	9,936799	10,23565	50	9,966653	10,38996
52 0	9,896532	10,10519	60 0	9,937531	10,23856	68 0	9,967166	10,39359
10	9,897516	10,10980	10	9,938257	10,24148	10	9,967674	10,39724
20	9,898494	10,11241	20	9,938980	10,24442	20	9,968178	10,40091
30	9,899467	10,11502	30	9,939697	10,24736	30	9,968678	10,40460
40	9,900433	10,11764	40	9,940409	10,25031	40	9,969173	10,40832
50	9,901391	10,12026	50	9,941116	10,25327	50	9,969665	10,41206
53 0	9,902349	10,1228961	0	9,941819	10,25625	69 0	9,970152	10,41582
10	9,903298	10,12552	10	9,942517	10,25923	10	9,970634	10,41961
20	9,904241	10,12815	20	9,943210	10,26223	20	9,971112	10,42342
30	9,905179	10,13079	30	9,943898	10,26524	30	9,971588	10,42726
40	9,906111	10,13344	40	9,944582	10,26825	40	9,972858	10,43113
50	9,907037	10,13609	50	9,945261	10,27128	50	9,972524	10,43502
54 0	9,907958	10,1387462	0	9,945935	10,27433	70 0	9,972986	10,43893
10	9,908873	10,14140	10	9,946604	10,27738	10	9,973443	10,44288
20	9,909782	10,14406	20	9,947269	10,28044	20	9,973897	10,44685
30	9,910686	10,14673	30	9,947929	10,28352	30	9,974346	10,45085
40	9,911584	10,14941	40	9,948584	10,28671	40	9,974792	10,45488
50	9,912477	10,15209	50	9,949235	10,28972	50	9,975283	10,45894
55 0	9,913364	10,1547763	0	9,949881	10,29283	71 0	9,975670	10,46303
10	9,914246	10,15747	10	9,950522	10,29596	20	9,976103	10,46715
20	9,915123	10,16016	20	9,951159	10,29911	20	9,976532	10,47130
30	9,915994	10,16287	30	9,951791	10,30226	30	9,977956	10,47548
40	9,916859	10,16558	40	9,952411	10,30543	40	9,977377	10,47969
50	9,917719	10,16829	50	9,953042	10,30862	50	9,977794	10,48394

The TABLE of *Sines* and *Tangents*.

D. M	*Sines.*	*Tang.*	D. M.	*Sines.*	*Tang.*	D. M	*Sines.*	*Tang.*
72 0	9,978206	10,48822	78 0	9,990404	10,67253	84 0	9,997614	10,97838
10	9,978615	20,49254	10	9,990671	10,67878	10	9,997732	10,99070
20	9,979019	10,49689	20	9,990935	10,68512	20	9,997873	11,00338
30	9,979419	10,50128	30	8,991193	10,69154	30	9,997996	11,01642
40	9,879816	10,50570	40	9,991448	10,69805	40	9,998106	11,02987
50	9,980208	10,51016	50	9,991699	10,70465	50	9,998232	11,04373
73 0	9,980597	10,51466	79 0	9,991947	10,71135	85 0	9,998344	11,05893
10	9,980980	10,51920	10	9,992190	10,71814	10	9,998453	11,07284
20	9,981361	10,52378	20	9,992430	10,72504	20	9,998558	11,08815
30	9,981737	10,52839	30	9,992666	10,73203	30	9,998659	11,10402
40	9,982109	10,53305	40	9,992898	10,73915	40	9,998757	11,12047
50	9,982477	10,53776	50	9,993127	10,74635	50	9,998851	11,13757
74 0	9,982842	10,54250	80 0	9,993351	10,75368	86 0	9,998941	11,15536
10	9,983202	10,54729	10	9,993572	10,76113	10	9,999027	11,17390
20	9,983558	10,55213	20	9,993789	10,76870	20	9,999110	11,19326
30	9,983910	10,55701	30	9,994003	10,77639	30	9,999189	11,21351
40	9,984259	10,56194	40	9,994212	10,78422	40	9,999265	11,23475
50	9,984603	10,56692	50	9,994418	10,79218	50	9,999336	11,25708
75 0	0,984943	10,57195	81 0	9,994620	10,80029	87 0	9,999404	11,28060
10	9,985280	10,57703	10	9,994818	10,80854	10	9,999469	11,30547
20	9,985613	10,58216	20	9,995012	10,01694	20	9,999529	11,33184
30	9,985942	10,58534	30	9,995203	10,82550	30	9,999586	11,35991
40	9,996266	10,59258	40	9,995390	10,83423	40	9,999640	11,38990
50	9,986587	10,59788	50	9,995573	10,84312	50	9,999689	11,42212
76 0	9,986904	10,60323	82 0	9,995753	10,85220	88 0	9,999735	11,45692
10	9,987217	10,60864	10	9,995928	10,86146	10	9,999778	11,49473
20	9,987526	10,61411	20	9,996100	10,87091	20	9,999816	11,53615
30	9,987832	10,61965	30	9,996269	10,88057	30	9,999851	11,58193
40	9,988133	10,62524	40	9,996433	10,89044	40	9,999882	11,63310
50	9,988430	10,63091	50	9,996594	10,90053	50	9,999910	11,69112
77 0	9,988724	10,63664	83 0	9,996751	10,91086	89 0	9,999934	11,77508
10	9,989014	10,64243	10	9,996904	10,92142	18	9,999954	11,83726
20	9,989299	10,64830	20	9,997053	10,93225	20	9,999971	11,93419
30	9,989582	10,65428	30	9,997195	10,94334	30	9,999983	12,05914
40	9,989860	10,66026	40	9,997341	10,95472	40	9,999993	12,23524
50	9,990134	10,66635	50	9,997480	10,96639	50	9,999998	12,5362
						90 0	10,000000	Infinite.

S CHAP.

CHAP. II.

The Explanation and Uſe of the Table of LOGARITHMS.

THE Table of *Logarithms* following conſiſteth of two Rows or Columns, the firſt of which, (namely that towards the left Hand, having the word *Num.* at the Head thereof) containeth all abſolute Numbers increaſing by an Unit, from 1 to 1000.

In the other Columns are placed the *Logarithms* of thoſe abſolute Numbers.

By this Table the *Logarithm* of any abſolute Number under 1000 may be readily found: Or if any Logarithm, whoſe abſoſolute Number exceedeth not 1000, be given, this Table will plainly diſcover what abſolute Number anſwereth thereunto. The Uſe of this Table will appear by the Propoſitions following.

PROP. I.

A Number being given, to find the Logarithm *thereof.*

LET it be required to find out the Logarithm of 223. Firſt ſeek 223 in the firſt Column of the Table, under the word *Num.* and againſt it, in the ſecond Column, you ſhall find 2,348305, which is the Logarithm thereof.

Alſo, let it be required to find the Logarithm of 629: If you ſeek 629 in the firſt Column, againſt it, in the ſecond, you ſhall find 2,798651, which is the Logarithm thereof.

PROP. II.

A Logarithm *being given, how to find the abſolute Number thereunto belonging.*

LET 2,731589, be a Logarithm given, whoſe abſolute Number you may require. You muſt firſt ſeek this Number in the ſecond Column of the Table, under the word *Logarithm*, againſt which you ſhall find 539, which is the abſolute Number anſwering to that Logarithm.

¶ But in this Table, as in the Table of *Sines*, if you cannot find the direct *Logarithm* which you look for in the Table, you muſt take the neareſt thereunto.

The

The TABLE of *Logarithms.*

Num.	*Logarith.*	*Num.*	*Logarith.*	*Num.*	*Logarith.*
1	0,000000	51	1,707570	101	2,004321
2	0,301030	52	1,716003	102	2,008600
3	0,477121	53	1,724276	103	2,012837
4	0,602060	54	1,732394	105	2,017033
5	0,698970	55	1,740363	106	2,021189
6	0,778151	56	1,748188	104	2,025306
7	0,845098	57	1,755875	107	2,029384
8	0,903090	58	1,763428	108	2,033424
9	0,954242	59	1,770852	109	2,037426
10	1,000000	60	1,778151	110	2,041393
11	1,041393	61	1,785330	111	2,045323
12	1,079181	62	1,792392	112	2,049218
13	1,113943	63	1,799341	113	2,063078
14	1,146128	64	1,806180	114	2,056095
15	1,176091	65	1,812913	115	2,060698
16	1,204120	66	1,819544	116	2,064458
17	1,230449	67	1,826075	117	2,068186
18	1,255272	68	1,832509	118	2,071882
19	1,278754	69	1,838849	119	2,075547
20	1,301030	70	1,845098	120	2,079181
21	1,322219	71	1,851258	121	2,082785
22	1,342423	72	1,857332	122	2,086359
23	1,361728	73	1,863323	123	2,089905
24	1,380211	74	1,869232	124	2,093422
25	1,397940	75	1,875061	125	2,096910
26	1,414973	76	1,880814	126	2,100371
27	1,431365	77	1,886491	127	2,103804
28	1,447158	78	1,892095	128	2,107209
29	1,462398	79	1,897267	129	2,110589
30	1,477121	80	1,903089	130	2,113943
31	1,491362	81	1,908485	131	2,117271
32	1,505150	82	1,913814	132	2,120574
23	1,518514	83	1,919078	133	2,123852
34	1,531479	84	1,924279	134	2,127105
35	1,544068	85	1,929419	135	2,130334
36	1,556302	86	1,934498	136	2,133539
37	1,568202	87	1,939519	137	2,136721
38	1,579783	88	1,944483	138	2,139879
39	1,591065	89	1,949390	139	2,143015
40	1,602060	90	1,954242	140	2,146128
41	1,612784	91	1,959041	141	2,149219
42	1,623249	92	1,963788	142	2,152288
43	1,633468	93	1,968483	143	2,155336
44	1,643453	94	1,973128	144	2,158362
45	1,653212	95	1,977724	145	2,161368
46	1,662758	96	1,982271	146	2,164352
47	1,672098	97	1,986772	147	2,167317
48	1,681241	98	1,991226	148	2,170262
49	1,690196	99	1,995635	149	2,173186
50	1,698970	100	2,000000	150	2,176091

The TABLE of *Logarithms.*

Num.	*Logarith.*	*Num.*	*Logaarith.*	*Num.*	*Logarith.*
151	2,178977	101	2,303196	251	2,399674
152	2,181844	202	2,305351	252	2,401401
153	2,184691	203	2,307496	253	2,303101
154	2,187521	204	2,309630	254	2,404834
155	2,190332	205	2,311754	255	2,406540
156	2,193125	206	2,313867	256	2,408239
157	1,195899	207	2,315970	257	2,409933
158	2,198657	208	2,318063	258	2,411619
159	2,201397	209	2,210146	249	2,413299
160	2,204119	210	2,322219	260	2,414973
161	2,206826	211	2,324282	251	2,416641
162	2,209515	212	2,326336	262	2,418301
163	1,212187	213	2,328379	263	2,419956
164	2,214844	214	2,330414	264	2,421604
165	2,217484	215	2,332438	265	2,423246
166	2,220108	216	2,334454	266	2,424882
167	2,222716	216	2,336459	267	2,426411
168	2,225309	218	2,338456	268	2,428135
169	2,227887	219	2,340444	269	2,429752
170	2,230449	220	2,342227	270	2,431364
171	2,232996	221	1,344392	271	2,432969
172	2,235528	222	2,346353	272	2,434569
173	2,238046	223	2,348305	273	2,436163
174	2,240549	224	2,350248	274	2,437751
175	2,243038	225	2,352183	275	2,449333
176	2,245513	226	2,354108	276	2,440999
177	2,247973	227	2,356026	277	2,442479
178	2,250420	228	2,357935	278	2,444045
179	2,252853	229	2,359835	279	2,445604
180	2,255273	230	2,361728	280	2,447158
181	2,257679	231	2,363612	281	2,448706
182	2,260071	232	2,365488	282	2,450249
183	2,262451	233	2,367356	283	2,451786
184	2,264818	234	2,369216	284	2,553318
185	2,267172	235	2,371068	285	2,454845
186	2,269513	236	2,372912	286	2,456365
187	2,271842	237	2,374748	287	2,459889
188	1,274158	238	2,376577	288	2,459392
189	2,276462	239	2,378398	289	2,460898
190	2,278754	240	2,380211	290	2,365393
191	2,281083	241	2,382017	291	2,463893
192	2,283301	242	2,383815	292	2,462398
193	2,285557	243	2,385606	293	2,466868
194	2,287802	244	2,387389	294	2,468347
195	2,290035	245	2,389166	205	2,469822
196	2,292256	246	2,390935	296	2,471292
197	2,294466	247	2,392697	297	2,472756
198	2,296665	248	2,394452	298	2,474216
199	2,298853	249	3,396199	289	2,475671
200	2,301029	250	2,397940	300	2,477121

The TABLE of *Logarithms.*

Num.	*Logarith.*
301	2,478566
302	2,480007
303	2,481443
304	2,482874
305	2,484299
306	2,485721
307	2,487138
308	2,488551
309	2,489958
310	2,491362
311	2,492760
312	2,494155
313	2,495544
314	2,496929
315	2,498311
316	2,499687
317	2,501059
318	2,502427
319	2,503791
320	2,505149
321	2,506505
322	2,507856
323	2,509203
324	2,510545
325	2,511883
326	2,513218
327	2,514548
328	2,515874
329	2,517196
330	2,518514
331	2,519828
332	2,521138
333	2,522444
334	2,523746
335	2,525045
336	2,526339
337	2,527629
338	2,528916
339	2,530199
340	2,531479
341	2,532754
342	2,534026
343	2,535294
344	2,536558
345	2,537819
346	2,539076
347	2,540329
348	2,541579
349	2,542825
350	2,544068
351	2,545307
352	2,546543
353	2,547775
354	2,549005
355	2,550228
356	2,551449
357	2,552668
358	2,553883
359	2,555094
360	2,556303
361	2,557507
362	2,558709
363	2,559907
364	2,561101
365	2,562293
366	2,563481
367	2,564666
368	2,565848
369	2,567026
370	2,568202
361	2,569374
372	2,570543
373	2,571709
374	2,572872
375	2,574031
376	2,575188
377	2,576341
378	2,577492
379	2,578639
380	2,579784
381	2,580925
382	2,582063
383	2,583199
384	2,584331
365	2,584461
386	2,586587
387	2,587711
388	2,588832
380	2,589949
390	2,591065
391	2,592177
392	2,593286
393	2,594393
394	2,595496
395	2,596597
396	2,597695
397	2,598790
398	2,599883
390	2,600973
400	2,602059
401	2,603144
409	2,604226
403	2,605305
404	2,606381
405	2,607455
406	2,608526
407	2,609594
408	2,610660
409	2,611723
410	2,612784
411	2,613842
412	2,614897
413	2,615950
414	2,617000
415	2,618048
416	2,619093
417	2,620136
418	2,621176
419	2,622214
420	2,623249
421	2,624282
422	2,625312
423	2,626340
424	2,627366
425	2,628389
426	2,629409
427	2,630428
428	2,631444
429	2,632457
430	2,633468
431	2,634477
432	2,635484
433	2,636488
434	2,647489
435	2,638488
436	2,539486
437	2,640481
438	2,641475
439	2,642465
440	2,643453
441	2,644439
442	2,645422
443	1,646404
444	2,647383
445	2,648360
446	2,649335
447	2,650308
448	2,651278
449	2,652246
450	2,653213

The TABLE of *Logarithms*.

Num.	Logarith.	Num.	Logarith.	Num.	Logarith.
451	2,654177	501	2,699838	551	2,741152
452	2,655138	502	2,700704	552	2,741439
453	2,656098	503	2,701568	553	2,742725
454	2,657056	504	2,602430	554	2,743509
455	2,658011	505	2,703291	555	2,744293
456	2,658966	506	2, 04151	556	2,745075
457	1,659910	507	2,705008	557	2,745855
458	2,660865	508	2,705864	558	2,736634
459	2,661813	509	2,706718	559	2,747412
460	2,662758	510	2,707570	560	2,748188
461	2,663701	511	2, 08421	561	2,748963
462	2,664642	512	2,709269	562	2,749736
463	1,665581	513	2,710117	563	2,750508
464	2,666518	514	2,710963	564	2,751279
465	2,667453	515	2,711807	565	2,752048
466	2,668386	516	2,712649	566	2,752816
467	2,669317	517	2,713491	567	2,753583
368	2,670246	518	2,714329	568	2,754348
469	2,671173	519	2,715167	569	2,755112
470	2,672098	520	2,716003	570	2,755875
471	2,673021	521	2,716838	571	2,756636
472	2,673942	522	2,717671	572	2,757396
473	2,674861	523	2,718502	573	2,758155
474	2,675778	524	2,719331	574	2,785912
475	2,676694	525	2,720159	575	2,759968
476	2,677607	526	2,720986	576	2,760422
477	2,678518	527	2,621811	577	2,751176
478	2,679428	528	2,722634	578	2,761928
479	2,680336	529	2,723456	579	2,762679
480	2,681241	530	2,724276	580	2,763428
481	2,682145	531	2,725095	581	3,764176
482	2,683047	532	2,725912	582	2,764923
483	2,683947	533	2,726727	583	2,765669
484	2,684845	534	2,727541	584	2,766413
485	2,685742	535	2,728354	585	2,767156
486	2,686636	536	2,729165	586	2,767898
487	2,687529	537	2,729974	587	2,768638
488	2,688419	538	2,730782	588	2,769377
489	2,689309	539	2,731589	589	2,770115
490	2,690196	540	2,732394	590	2,770852
491	2,691081	341	2,733197	591	2,771587
492	2,691965	542	2,733999	592	2,772322
493	2,692847	543	2,734799	593	2,873055
494	2,693727	544	2,735599	594	2,7737786
495	2,694605	545	2,736397	505	1,7745117
496	2,695482	546	2,737192	596	2,7752446
497	2,696356	547	2,737987	597	2,775974
498	2,697229	548	2,738781	598	2,776701
499	2,698101	549	2,739572	589	2,777427
500	2,698970	550	2,740363	600	2,778151

The TABLE of *Logarithms.*

Num.	Logarith.
601	1,778874
602	2,779596
603	2,780317
604	2,781037
605	2,781755
606	1,782473
607	2,783189
608	2,783904
609	2,784617
610	2,785329
611	2,786041
612	2,786751
613	2,787460
614	2,788164
615	2,788875
616	2,789581
617	2,790285
618	2,790988
619	2,791691
620	2,792392
621	2,793092
622	2,793791
623	2,794488
624	1,795185
625	2,795880
626	2,796574
627	2,797268
628	2,797959
629	2,798651
630	2,799341
631	2,800029
632	2,800717
633	2,801404
634	2,802080
635	2,802773
636	2,803457
637	2,804139
638	2,804821
639	2,805501
640	2,806179
641	2,806558
642	2,807535
643	2,808211
644	2,808886
645	2,809559
646	2,810233
647	2,810904
648	2,811575
649	2,812245
650	2,812914

Num.	Logarith.
651	2,813581
652	2,814248
653	2,814913
654	2,815578
655	2,816241
656	2,816904
657	2,817565
658	2,818226
659	2,818885
660	2,819543
661	2,820201
662	2,820858
663	2,801514
664	2,822168
665	2,822822
666	2,823474
667	2,824126
668	2,824776
669	2,825426
670	2,826075
671	2,826723
672	2,827369
673	2,828015
674	2,828659
675	2,829304
676	0,829947
677	2,830589
678	2,831229
679	2,831869
680	2,832509
681	2,833147
682	2,833784
683	2,834421
684	2,835056
685	2,835691
686	2,836324
687	2,836957
688	2,837588
689	2,838219
690	2,838849
691	2,839478
692	2,840106
693	2,840733
694	2,841359
695	2,841985
696	2,842609
697	2,843233
698	2,843855
699	2,844477
700	2,845098

Num.	Logarith.
701	2,845718
702	2,846337
703	2,846955
705	2,847573
706	2,848189
704	2,848805
707	2,849419
708	2,850033
709	2,850646
710	2,851258
711	2,851869
712	2,852479
713	2,853089
714	2,853698
715	2,854306
716	2,854913
717	2,855519
718	2,856124
719	2,856729
720	2,857332
721	2,857935
722	2,858537
723	2,859138
724	2,859739
725	2,860338
726	2,860937
727	2,861534
728	2,862131
729	2,862728
730	2,863323
731	2,863917
732	2,864511
733	2,865104
734	2,865696
735	2,866287
736	2,866878
737	2,867467
738	2,868056
739	2,868643
740	2,869232
741	2,869818
742	2,870404
743	2,870989
744	2,871573
745	2,872156
746	2,872739
747	2,873321
748	2,873902
749	2,874482
750	2,875061

The TABLE of *Logarithms.*

Num.	Logarith.
751	2,875639
752	2,876218
753	2,876795
654	2,877371
755	2,177947
756	2,878522
757	2,879096
758	2,879669
759	2,880242
760	2,880814
761	2,881385
762	2,881955
763	2,882525
764	2,883093
765	2,883661
766	2,884229
767	2,884795
768	2,885361
769	2,885926
770	2,886491
771	2,887054
772	2,887617
773	2,888179
775	2,888741
775	2,889302
776	2,889862
777	2,890421
778	2,890979
779	2,891537
780	2,892095
781	2 892651
782	2,893207
783	2,893762
724	2,894316
725	2,894869
786	2,895423
787	2,895975
788	2,896526
789	2,897077
790	2,897627
791	2,898176
792	2,898725
693	2,899273
794	2,899821
795	2,900367
796	2,900913
797	9,901458
798	2,902003
799	2,902547
800	2,903089
801	2,903633
802	2,904174
023	2,904716
804	2,905256
805	2,905796
206	2,906335
807	2,906874
808	2,907412
809	2,907949
810	2,908485
811	2,909021
812	2.909556
813	2,910051
814	2,910624
115	2,911158
816	2,911690
817	2,912222
818	2,912773
819	2,913284
820	2,913814
821	2,914343
822	2,914872
823	2,915399
824	2,915927
825	2,916454
826	2,916980
827	2,917506
828	2,918030
829	2,918555
830	1,919078
831	2,919602
831	2,920123
833	2,920645
834	2,921162
835	2,921686
836	2,922206
837	2,922725
838	2,923244
839	2,923762
840	2,924279
841	2,924796
842	2,925312
843	2,925825
844	2,926342
845	2,926857
846	2,927370
847	2,927883
848	2,928396
849	2,928908
850	2,929419
851	2,929929
852	2,935439
853	2,930949
854	2,931458
855	2,931966
856	2,932474
857	2,932981
858	2,933487
859	2,933993
860	2,934498
861	2,935003
862	2,935507
863	2,936011
864	2,936514
865	2,937016
866	2,937518
867	2,938019
868	2,938519
869	2,939019
870	2,939519
871	2,940018
872	2,940516
873	2,941014
874	2,941511
875	2,942008
876	2,942504
877	2,942999
878	2,943495
979	2,943989
880	2,944483
881	2,944976
882	2,945468
883	2,945961
884	2,946452
885	2 946943
886	2,947434
887	2,947924
888	2,948415
889	2,948902
890	2,949390
891	2,949878
892	2,950365
893	2,950851
894	2,951338
895	2,951823
896	2,952308
897	2,952792
898	2,953276
899	2,953759
900	2,954242

The TABLE of *Logarithms.*

Num.	*Logarith.*	*Num.*	*Logarith.*	*Num.*	*Logarith.*
901	2,954725	935	2,970812	968	2,985875
902	2,955207	936	2,971276	969	2,986324
903	2,955688	937	2,971739	970	2,986772
904	2,956168	938	2,972203	971	2,987219
905	2,956640	939	2,972666	972	2,987666
906	2,957128	940	2,973128	973	2,987113
907	2,957607	941	2,973589	974	2,988559
908	2,958086	942	2,974050	975	2,989005
909	2,958564	943	2,974512	976	2,989449
910	2,959041	944	2,974972	977	2,989895
911	2,959518	945	2,975432	978	2,990339
912	2,959995	946	2,975891	979	2,990783
913	2,960471	947	2,976349	980	2,991226
914	2,960946	948	2,976808	981	2,991669
915	2,961421	949	2,977266	982	2,992111
916	2,961895	950	2,977724	983	2,992554
917	2,962369	951	2,978181	984	2,992995
918	2,962842	952	2,978637	985	2,993436
919	2,963315	953	2,979093	986	2,993877
920	2,963788	954	2,979548	987	2,994317
921	2,964259	955	2,980003	988	2,994756
922	2,964731	956	2,980458	989	2,995196
923	2,965202	957	2,980912	990	2,995635
924	2,965672	358	2,981366	991	2,996074
925	2,966142	959	2,981819	992	2,996512
926	2,966611	960	2,982271	993	2,996949
927	2,967079	961	2,982723	994	2,997386
928	2,967548	962	2,983175	995	2,997823
929	2,966611	963	2,983626	996	2,998259
930	2,968483	964	2,984077	997	2,998695
931	2,968949	965	2,984527	998	2,999133
932	2,969416	966	2,984977	999	2,999565
933	2,969882	967	2,985426	1000	3,000000
934	2,970347				

CHAP. III.

The Uſe of the Tables of Sines, Tangents, *and* Logarithms, *in the reſolving of plain Triangles.*

BEfore I come to ſhew how the Quantity of the ſides and angles of any Triangle may be found, by help of the former Tables, it will be convenient, firſt, to deliver theſe following Conſiderations and Theorems, as Neceſſaries thereunto.

1. A *Triangle* is a figure conſiſting of three ſides, and three angles, as C B A (*in fig.* 1.)

2. Any two ſides of a Triangle are called the ſides of the angle comprehended by them; as the ſides C B and A B are the ſides containing the angle C B A.

3. The meaſure of an *Angle* is the Quantity of an arch of a Circle deſcribed on the angular Point, and cutting both the containing ſides of the ſame angle; as in the Triangle A H E following, the arch C B is the meaſure of the angle at A; the arch K D is the meaſure of the angle at the E; and the arch F G is the meaſure of the angle at H. Each of theſe arches are deſcribed on the angular Points A, H, E, and cut the containing ſides thereof.

4. A *Degree* is the 360th part of any Circle: Therefore

5. A *Semi-circle* containeth 180 Degrees: And,

6. A *Quadrant* containeth 90 Degrees.

7. The complement of an Angle leſs than a Quadrant, is ſo much as that Angle wanteth of 90 Degrees: As if the Angle H A E ſhould contain 50 Degrees, the Complement thereof would be 40 Degrees; For if you take 50 from 90, there will remain 40.

8. The ſupplement of an Angle to a Semi-circle, is the remainder thereof to 180 Degrees.

9. An Angle is either Right, Acute, or Obtuſe.

10. A *Right angle* is that whoſe meaſure is a Quadrant.

11. An *Acute angle* is leſs than a Right-angle.

12. An *Obtuſe angle* is greater than a Right-angle.

13. A *Triangle* is either Right-angled or Oblique-angled.

14. A *Right-angled* Triangle is that which hath one right-angle, (or an angle containing juſt 90 Degrees); as the Triangle (*fig.* 2.) A H E is right-angled at E, the angle at E being 90 Degrees.

15. In every right-angled Triangle, that ſide which ſubtendeth (or lieth oppoſite to) the right-angle, is called the *Hypotenuſal:* And of the other two ſides, the one is called *Perpendicular*, and the other the *Baſe*, at pleaſure; but moſt commonly the ſhorter is called the *Perpendicular*, and the longer is called the *Baſe*. So in

in the former *Triangle*, the ſide A H is the *Hypotenuſal*, H E the *Baſe*, and A E the *Perpendicular*.

16. In every right-angled Triangle, if you have one of the acute angles given, the other is alſo given, it being the complement thereof to 90 Degrees. And in the Triangle A H E, ſuppoſe there were given the Angle A H E 40 Degrees, then by conſequence the Angle H A E muſt be 50 Degrees, which is the complement of the other to 90 Degrees.

17. the three Angles of any right-lined Triangle whatſoever, are equal to two right-angles, or to 180 Degrees; ſo that if in any right-lined Triangle you have any two of the Angles given, you have the third angle alſo given, it being the Supplement of the other two to 180 Degrees.

So in this Triangle A B C (*fig.* 3.) if there were given the angle B A C, 30 degrees, and the Angle A C B, 130 degrees, I ſay, by conſequence, there is alſo given the third Angle A B C, 20 degrees, it being the Supplement of the other two to 180 deg. For, the two given Angles, A 30, and C 130 degrees, being added together, make 160 deg. which being taken from 180 deg. there remain 20 deg. the quantity of the third Angle A B C.

18. In all plain Triangles whatſoever, the ſides are in proportion one to another, as the Sines of the Angles oppoſite to thoſe ſides. So in the Triangle A B C. the Sine of the Angle A C B, is in ſuch proportion to the ſide A B, which is oppoſite to it, as the Sine of the angle C A B is to the ſide B C, which is oppoſite to that angle; or, as the Sine of the Angle A B C, is to the oppoſite ſide A C.

CHAP. IV.

Containing the Doctrine of the Dimenſion of right-lined Triangles, whether Right angled, or Oblique-angled, and the ſeveral Caſes therein reſolved both by Tables, *and alſo by Lines of Artificial* Numbers, Sines, *and* Tangents.

HAving, in the foregoing Chapters of this Book, explained and ſhewed the Uſe of the Tables of *Sines* and *Logarithms*, and alſo delivered divers neceſſary Theorems relating to the menſuration of plain Triangles, I come now to ſhew how a plain Triangle may be reſolved; that is, by having any three of the ſix parts of a plain Triangle given, to find a fourth, both by the Tables of

Sines

Sines and *Logarithms*, and alſo by the Lines of Artificial *Numbers*, *Sines*, and *Tangents*, on the Index of your Table; ſo that when your Tables are not ready at Hand, you may make uſe of theſe Lines, which will ſufficiently ſupply the want of them, as I before intimated.

¶ In all the Caſes following I have made uſe but of two Triangles for Examples, one Right-angled, and the other Obliqne-angled: But in either of them I have expreſſed all the Varieties that are neceſſary; ſo that three parts being given in any of them, a fourth may be found at pleaſure.

The ſeveral Caſes of a right-angled Triangle will beſt appear when they are employed in the taking of Heights, as is ſhewed in the next Book; and the Oblique-angled Triangle for the taking of Diſtances, there alſo taught: So that if the line C A, in the right-angled Triangle C A B (*fig.* 1.) a Tree, Tower, or Steeple, and that you would know the Height thereof, you muſt obſerve with your Inſtrument, the Angle C B A, and meaſure the Diſtance B A; ſo have you in the right-angled Triangle A B C, the Baſe A B, and the angle at the Baſe C B A: Then may you (by the firſt Caſe following) find the ſide C A, which is the Height of the thing required; namely, the length of the Line C A, be it Tree, Steeple, or other Object.

Of Right-angled plain TRIANGLES.

CASE I.

In a Right-angled plain Triangle, the Baſe, and the Angle at the Baſe, being given, to find the Perpendicular.

IN the right-angled Triangle A B C (*fig.* 1.) there is given the Baſe thereof, B A, 400 Feet, and the Angle at the Baſe C B A, 30 deg. and it is required to find the Perpendicular C A.

Now, Becauſe the angle C B A is given 30 deg. the angle B C A is alſo given 60 deg. it being the complement of the other to 90 deg. and therefore the angle B C A is 60 deg. Then to find the Perpendicular C A, the proportion is,

As

As the Sine of the Angle BCA, 60 degrees, (which is) 9,937531
is to the Logarithm of the Side BA, 400 Foot, (which is) 2,602059
So is the Sine of the angle CBA, 30 degrees, (which is) 9,698970

The Sum of the ſecond and third Numbers added--- 12,301029
The firſt Number ſubtracted from the Sum ----- 9,937531
To the Logarithm of the ſide C A, (which is) 2,363498

The neareſt abſolute Number anſwering to this Logarithm is 231 *ferè*, and that is the length of the ſide C A, in Feet, which was the thing required.

General Rule.

In all Proportions whatſoever, wrought by Sines Tangents *and* Logarithms, *you muſt obſerve this for a general Rule*, viz. *To add the ſecond and third Numbers together, and from the ſum of them to ſubtract the firſt Number; ſo ſhall the remainder anſwer the Queſtion demanded; as by the former Work you may perceive, where the Logarithm of the ſide* B A 2,602059 (*which is the ſecond Term or Number*) *is added to the Sine of the Angle* C B A 9,698970, (*which is the third Term or Number*) *and from the ſum of them* (*namely, from* 12,301029) *is ſubtracted* 9,937531, *the Sine of the Angle* B C A: *which is the firſt Number, and there remaineth* 2,363498, *which is the Logarithm of* 231 *almoſt; and that is the length of the ſide required in Feet.*

The ſame manner of Work is to be obſerved in all the Caſes following, as will plainly appear.

How to perform the ſame Work by the Lines of Sines *and* Numbers.

Theſe kind of Proportions are wrought more eaſily by help of the Lines of Artificial Numbers, Sines, and Tangents, on the Index of your Table, or any other Scale, and exact enough for any ordinary occaſion. But before we ſhew how to uſe theſe Lines, it is convenient to ſpeak of reading or numbering on them; and firſt on the line of *Numbers*. From the Left-hand to the Right-hand are Diviſions of the longer ſort numbered 1, 2, 3, 4, 5, 6, 7, 8, 9. 1, 2, 3, 4, 5, 6, 7, 8, 9, 1. So that the Beginning, End, and Middle are numbered 1: And whatſoever Value is ſet on the firſt 1, the ſecond or middlemoſt, is 10 times ſo much; and laſt 1, an 100 times ſo much: And whatſoever Value is ſet on the {firſt / middlemoſt} 1, the ſame

Value is ſet on the numbered Diviſions immediately following; the { firſt / middle- / moſt } 1. That is, if the firſt 1 be called one, then ſhall the { 2 / 3 / 4 / &c. } immediately following it, be called { two, / three / four, / &c. } And if the firſt 1 be called 10, then the { 2 / 3 / 4 / &c. } immediately following it, ſhall be called { twenty, / thirty, / forty, / &c. } And ſo if the firſt 1 be called 100, then the { 2 / 3 / 4 / &c. } immediately following it, ſhall be called { 200 / 300 / 400 / &c. } and ſo on. And in like manner, if the middlemoſt 1, be called ten, (which is when the firſt 1 is called one) then the { 2 / 3 / 4 / &c. } immediately following the middlemoſt 1, is called, { twenty, / thirty, / forty, &c. } And if the middlemoſt 1 is called 100 (which is when the firſt 1 is called ten) then the { 2 / 3 / 4, / &c. } immediately following the middlemoſt 1, is called { 200 / 300 / 400 / &c. } &c.

Secondly, Between every two of theſe figured Diviſions are 10, (ſhorter than the primary or figur'd ones) and called *Secondary Diviſions*. And the Value of any *Secondary*, is juſt $\frac{1}{10}$th part of that primary one which immediately preceeds it: So if a primary Diviſion be valued { hundreds, / tens, / units, } the ſecondary ones immediately following it, are { tens, / units, / 10th parts. } So if the primary Diviſions were

hundreds,

{hundreds, tens, units,} then the fifth or longeſt Diviſion between 3 and 4,

ſignifies {350, 35, $3\frac{1}{10}$}.

Laſtly, Between theſe *Secondary Diviſions* are other ſhorter ones, called *Tertiary*; in ſome Places 10 between two *ſecondary* ones (as thoſe immediately following the middle Figures); and in this Place the Value of the *tertiary* ones are each $\frac{1}{10}$th of the Value of the preceeding *ſecondary*; and in ſome places 5 between every *ſecondary* (as thoſe immediately following the latter Figure of 2): And here the Value of the *tertiary* ones are $\frac{2}{10}$ths of the Values of the preceeding *ſecondary*: And ſo if we imagine one ſingle Diviſion between each of theſe laſt *tertiary* ones, every one of them will be $\frac{1}{10}$th of their *ſecondary* ones. In ſome Places between the *ſecondary* is only one *tertiary*, whoſe Value is $\frac{5}{10}$ths of its preceeding *ſecondary*; the other *tertiary* ones here, are to be ſupplied in the Imagination, as before.

Therefore to find upon the Line 143, make the firſt 1 ten, and the middlemoſt one 100; then of the 90 on towards 2, count till you come to the 4th *ſecondary* Diviſion, which gives the Number 140. Laſtly, Count forwards three *tertiary* Diviſions, and there will be the place of the Number 143. In like manner, to find the Number 247; call the middlemoſt 1 an hundred, and ſo the 2 following it 200; then go on four of the *ſecondary*, which will give the place of 240: Laſtly, Go ſtill onwards to 3 and $\frac{1}{2}$ of the *tertiary*, and you will have the place of 247.

And here *note*, That the Diviſions following the middlemoſt one, are beſt to ſignify three places of Figures; but thoſe that immediately follow the firſt 1, to ſignify a Number of one or two places; eſpecially to a Learner.

And now for the line of *Sines*: We are to obſerve they begin a little below one Degree, and run with 2,3,4,5,6,7,8,9,10,20,30, 40,50,60,70,80,90. And that the Values are not changeable, as on the Numbers, but fix'd by the Figures annex'd.

The *ſecondary Diviſions* on the Left-hand of 10, denote the parts of a Degree; and where there are {12, 6, 4, 3, 2} each ſignifies {5, 10, 15, 20, 30} Min. of a Degree. The *ſecondary* Diviſions from 10 upwards (where they are in Number 10 between their *primary*) ſignify whole Degrees; and the *tertiary* ones between them, denote parts of a Degree.

Where

Where there are but five *ſecondary* Diviſions (as ſometimes there are no more between 70 and 80) each Diviſion denotes two Degrees.

Between 80 and 90, there generally is only one Diviſion, which is the 85th Degree.

The Line of *Tangents* begins as the Line of Sines doth, and goes on to 45 Degrees; the Degrees above 45 are ſupplied by thoſe below 45, and and uſually numbered backwards. The Places here are fix'd, as on the *Sines*, and have not changeable Values, as on the Number.

For, as in the preceeding Example, the proportion was

As the Sine of the Angle B C A, 60 degrees,
is to the Logarithm of the ſide B A, 400 Feet;
So is the Sine of the angle C B A, 30 degrees,
to the Logarithm of the ſide A C 231 Feet *feré*.

Therefore, if you ſet one foot of your Compaſſes at 60 degrees in the line of Sines, and extend the other foot to 400 in the line of Numbers; the ſame extent of the Compaſſes will reach from the Sine of 30 degrees to almoſt 231 in the line of Numbers, which is the length of the ſide A C, which was required.

Or rather thus: Extend the Compaſſes from the Sine of 60 degrees, to the Sine of 30 degrees in the line of Sines; the ſame extent will alſo reach from 400, in the line of Numbers, to almoſt 231, as before.

And thus, by theſe Artificial Lines, the Work is much abbreviated, there being need neither of Pen, Ink, Paper, or Tables, but only of your Compaſſes.---- And for the working by theſe Artificial Lines, this is

A General Rule.

If you ſet one foot of the Compaſſes in the firſt term of the Proportion, and extend the other to the ſecond term, the ſame extent ſhall reach the ſame way, either upwards or downwards; from the third term in the Proportion, to the fourth proportional Number ſought.

Or,

If you ſet one foot in the firſt term, and extend the other to the third term, the ſame extent ſhall reach from the ſecond term to the fourth alſo.

And here we are to obſerve not to croſs the Lines, as in the firſt Example was required, if it might be conveniently avoided.

The

The Baſe, and the Angle at the Baſe being given, to find the Hypotenuſal.

IN the ſame Triangle A B C, (*fig.* 1.) let there be given (as before) the Baſe A B, 400 Foot, and the angle A B C, 30 degrees, and let it be required to find the Hypotenuſal B C.

Now, becauſe the Angle C B A is given, the other Angle B C A is alſo given, and the Proportion is,

As the Sine of the angle B C A 60 degrees,	9,937531
is to the Logarithm of the ſide B A, 400 Feet,	2,602059
So is the Side of the angle C A B, 90 degrees,	10,000000
(the ſum of the ſecond and third Numbers added)	12,602959
(the firſt Number ſubtracted from the ſum,)	9,937531
to the Logarithm of the ſide B C, which is	2,664528

The neareſt abſolute Number anſwering to this Logarithm, is 462, and ſo many Feet is the Hypotenuſal B C.

This Work may be ſomewhat abbreviated, and ſo may all others of this kind, where the [*Radius*] or Sine of 90 degrees is ingredient; for, the Sine of 90 degrees conſiſting of 10, and certain Cyphers, neither increaſeth by Addition, nor decreaſeth by Subtraction, more than by the Unit. Wherefore, when the *Radius* or the Sine of 90 is to be ſet down, you may add the Unit only to the number next it, as I have here done, and then will the Work of this ſecond Caſe ſtand thus;

As the Sine of the angle B C A 60 degrees,	9,937531
is to the Logarithm of the ſide B C 400,	12,602059
So is the Sine of the angle C A B 90 deg.	
To the Logarithm of the ſide B C, which is----	2,664528

exactly agreeing with the former. And here you ſee, that in the firſt manner of working there are ſix lines of Figures uſed, and in this but three: but it is my Cuſtom to render things plain at firſt, and uſe Abbreviations afterwards.

By the Lines of Sines and Numbers.

The manner of work is altogether the ſame with that of the former Caſe: For the proportion being,

As the ſine of the angle B C A 60 degrees
is to the length of the ſide B A 400 foot,
So is the Sine of the angle C A B 90 degrees
to the length of the ſide C B 462; therefore

Extend the Compaſſes from the Sine of 60 degrees to the Sine of 90 degrees, the ſame extent will alſo reach from 400 to 462, as before.

CASE. III.

The Hypotenuſal and Angle at the Baſe being given, to find the Perpendicular.

IN the ſame Triangle, (*fig.*1.) let there be given the Hypotenuſal B C 462 Feet, and the angle at the Baſe C B A 30 degrees, to find the Perpendicular C A.

The angle C A B is a right-angle, or 90 degrees; and therefore the Proportion is,

As the Sine of the angle C A B 90 degrees,	10,00000
is to the Logarithm of the ſide B C 462,	2,664643
So is the Sine of the angle C B A 30 degrees,	
to the Logarithm of the ſide C A,	*2,363611

The number anſwering this Logarithm is 231 *ere*, and that is the length of the ſide C A in Feet.

Here the Work is ſomewhat abbreviated, for the angle C A B being a right-angle, and being the firſt term, when the ſecond and third terms are added together, the firſt is eaſily ſubtracted from it by cancelling the figure next your Left-hand, as you ſee in the Example: And ſo the reſt of that number is the Logarithm of the number ſought.

By the lines of Sines and Numbers.

Extend the Compaſſes from the Sine of 90 degrees, to the Sine of 30 degrees, the ſame extent will reach from 462 to 231; and that is the ſide C A.

The

CASE IV.

The Hypotenuſal and Angle at the Baſe being given, to find the Baſe.

LET there be given in the former Triangle, (*fig.* 1.) the Hypotenuſal B C 462, and the angle at the Baſe C B A 30 deg. then by conſequence the angle B C A muſt be 60 deg. the complement of the other to 90. How to find the ſide B A, the proportion is,

As the Sine of the angle C A B 90 degrees,	10,000000
is to the Hypotenuſal B C 462	2,664642
So is the the Sine of the angle B C A 60 degrees	9,937531
to the Logarithm of the Baſe B A,	*2,602173

The neareſt number anſwering to 2,602173, is the Logarithm of 400; and ſo long is the Baſe B A.

By the lines of Sines and Numbers.

Extend the Compaſſes from the Sine of 90 to the Sine of 60, the ſame Extent will reach from 462 to 400; which is the length of the Baſe B A.

CASE V.

The Perpendicular and Angle at the Baſe being given, to find the Hypotenuſal.

IF the Perpendicular C A (*fig.* 1.) be given 231, and the angle at the Baſe C B A 30 degrees, the Hypotenuſal B C may be found thus: For,

As the Sine of the angle C B A, 30 degrees,	9,698970
is to the Logar. of the Perpendicular C A 231,	12,363612
So is the Sine of the angle C A B 90 degrees,	10,000000
to the Logarithm of the Hypotenuſal B C,	2,664642

¶ Here, becauſe the angle C A B is a right angle, or 90 deg. and comes in the third place, I therefore only put an unite before the ſecond term, and from that ſecond term ſubtract the firſt term, and the remainder is 2,664642: The abſolute number anſwering thereunto is 462, the ſide B C.

By

By the lines of Sines and Numbers.

The diſtance between the Sine of 30 degrees and 90 degrees will be equal to the diſtance between 231 and 462; which giveth the ſide required.

CASE VI.

The Hypotenuſal and Perpendicular being given, to find the Angle at the Baſe.

IN the foregoing Triangle (*fig.* 1.) there is given the Hypotenuſal B C 462 Feet, and the Perpendicular C A 231 Feet, and it is required to find the angle C B A: the proportion is,

As the Logarithm of the Hypotenuſal B C 462,	2,664642
is the right-angle B A C 90 degrees,	10,000000
So is to the Logarithm of the Perpendicular C A 231,	12,363612
to the Sine of the Angle C B A 30 deg.	9,698970

By the Lines and Sines of Numbers.

Extend the Compaſſes from 462 to 231, the ſame extent will reach from the Sine of 90 degrees to the Sine of 30 degrees; which is the Quantity of the enquired angle C B A.

Of the Oblique-angled plain Triangles.

CASE. VII.

Having two Angles and a Side oppoſite to one of them given, to find the ſide oppoſite to the other.

IN the Triangle Q R S, (*fig.* 4.) there is given the angle Q S R, 24 deg. 20 min. and the angle Q R S 45 deg. 10 min. and the ſide Q S 303 Feet, and it is requir'd to find the ſide Q R.

¶ Here note, that in oblique-angled plain Triangles, as well as in right-angled, the ſides are in proportion one to the other, as the Sines of the angles oppoſite to thoſe ſides. Therefore,

As

As the Sine of the angle Q R S 45 deg. 10 min.	9,850745
is the Logarithm of the ſidd Q S 303 Feet,	2,481443
So is the Sine of the angle Q S R 24 deg 20 min.	9,614944
(the ſum of the ſecond and third terms)-----	12,096387
(the firſt term ſubtracted) - - - - - -	9,850745
To the Logarithm of the ſide Q R,	2,245642

The neareſt abſolute number anſwering to this Logarithm, is 176; and ſo many Feet is the ſide Q R.

By the Lines of Sines and Numbers.

The lines of Sines and Numbers will reſolve theſe Triangles by the ſame manner of Work as before. For,

If you extend the Compaſſes from the Sine of 45 deg. 10 min. to 24 deg. 20 min. the ſame extent will reach from 303 to 176, the length of the inquired ſide.

In like manner, if the angle R Q S, 110 deg. 30 min. and the angle Q R S, 45 deg. 10 min. and the ſide Q S, 303 Feet, had been given, the ſide R S required, the manner of Work had been the ſame. For,

As the Sine of the angle Q R S, 45 deg. 10 min.	9,850745
is to the Logarithm of the ſide Q S, 303 Feet,	2,481443
So is the Sine of R Q S 110 deg. 30 min. (or 69 deg. 30 min. which is the complement of 110 deg. 30 min. to 180 deg.)	9,971588
the ſum of the ſecond and third terms)	12,453031
(the firſt term ſubtracted) - - - - - - - - -	9,850745
to the Logarithm of the ſide R S,	2,602286

The abſolute Number anſwering to this Logarithm is 400; and ſo much is the ſide R S.

¶ In this Caſe, becauſe the angle R Q S is more than 90 degrees; you muſt therefore take the complement thereof to 180 degrees; ſo 110 deg. 30 min being taken from 180 degrees, there remains 69 deg. 30 min. whoſe Sine is the ſame with the Sine of 110 deg 30 min. and being uſed inſtead thereof, will effect the thing required. And the like is to be done as oft as you have an angle greater than 90 degrees.

By the lines of Sines and Numbers.

The Compaſſes being opened to the Diſtance between the Sine of 45 deg. 10 min. and 69 deg. the ſame Diſtance will reach from 303 to 400, as before.

CASE VIII.

Two Sides and an Angle oppoſite to one of them being given, to find the Angle oppoſite to the other.

IN the ſame Triangle (*fig.* 4.) let there be given the ſide QS 303, and QR 176, together with the angle QSR, 24 deg. 20 min. and let it be required to find the angle QRS, the Proportion is,

As the Logarithm of the ſide QR 176,	2,245513
is to the Sine of the Angle QSR, 24 deg. 20 min.	9,614944
So is the Logarithm of the ſide QS 303,	2,481443
(the ſum of the ſecond and third numbers)	12,096387
(the firſt number ſubtracted from the ſum)	2,245513
to the Sine of the angle QRS,	9,850374

The neareſt Degree in theſe ſmall Tables anſwering to the Sine is 45 deg. 10 min. which is the quantity of the angle QRS required.

By the lines of Sines and Numbers.

The Diſtance between 176 and 303 will be equal to the diſtance between 24 deg. 10 min. and 45 deg. 10 min.

When the ſide oppoſite to the ſought angle is leſs than the ſide oppoſite to the given one; the ſought angle is doubtful, and may be either that found in the Tables, or its Supplement to 180 degrees; both of them being poſſible.

CASE IX.

Having two Sides and the Angle contained by them given, to find either of the other Angles

THIS Caſe and the former will ſeldom come in uſe in Surveying, becauſe the thing required is an angle, which are moſt com-

commonly given, they being obſerved by Inſtrument, and therefore in this Place might be omitted: However I will ſhew how they may be reſolved by the Tables, and alſo by the proportional Lines, which is as followeth.

For performance of this Problem: Suppoſe there were given the ſide Q S 303 (*fig.* 4.) and the ſide R Q 176, and the Angle comprehended by them, namely the angle R Q S 110 deg. 30 min. and it were requir'd to find either of the other angles.

Firſt, Take the ſum and difference of the two given ſides; their ſum is 479, and their difference is 127. Then knowing that the the three angles of all right-lined Triangles are equal to two right-angles, or 180 deg. (*by the* 17th *Theor. of Chap.* 3.) therefore the angle R Q S being 110 deg. 30 min. if you ſubtract this angle from 180 deg. the remainder will be 69 deg 30 min. which is the ſum of the two unknown angles at R add S, the half whereof is 34 deg. 45 min.

The ſide Q S	303
The ſide Q R	176
The ſum of the ſides	479
The difference of the ſides	127

The half-ſum of the two unknown angles 34 deg. 45 min.

The ſum and difference of the ſides being thus found, and alſo the half-ſum of the two unknown angles, the proportion by which you muſt find the angles ſeverally is,

As the Logarithm of the ſum of the ſides, 479,	2,680335
is to the Log. of the difference of the ſides, 127,	2,103804
So is the Tangent of the half-ſum of the two unknown angles 34 deg. 45 min.	9,841187
(the ſum of the ſecond and third Numbers)	11,944991
(the firſt Number ſubtracted)	2,680335
to the Tangent of 10 deg. 25 min.	9,264656

Theſe 10 deg. 25 min, being added to the half-ſum of the two unknown angles, namely, to 34 deg. 45 min. the ſum will be 45 deg. 10 min. the Quantity of the angle Q R S, which is the greater angle of the two. Alſo, theſe 10 deg. 25 min being ſubtracted from the ſame half-ſum, there remain 24 deg. 20 min. for the angle Q S R, which is the leſſer of the unknown angles: The greater angle being always that which is oppoſite to the greater ſide. And thus are both the angles found which were ſought.

By the lines of Tangents and Numbers.

Extend the Compaſſes from the ſum of the ſides 479 to the differences of the ſides 127; the ſame extent upon the line of Tangents, will reach from the Tangent of 34 deg. 45 min. (which is the

the half-ſum of the two unknown angles) to the Tangent of 10 deg. 25 min. and theſe 10 deg. 25 min added to, and ſubtracted from the half-ſum, as before is ſhewed, will give the Quantity of either of the two unknown angles.

When on the Tangents the Diſtance reaches beyond 45; then as much as it reaches beyond, muſt be laid from 45 backwards.

CASE X.

The three ſides of a right-lined plain Triangle being given, how to find the Area, or the ſuperficial Content thereof.

FIrſt, Add the three ſides together, and from the half-ſum ſubtract each ſide ſeverally, to the end you may have the difference betwixt that half-ſum and each ſide: This done, add the Logarithms of the ſaid half-ſum and of thoſe differences together: And laſtly, Dividing the ſum of thoſe Logarithms by 2, you have the Logarithm of the ſuperficial Content, or Area of the Triangle.

EXAMPLE.

Let the Triangle given be A B C, (*fig.* 3.) the ſides thereof being 20, 13, 11, how much is the ſuperficial content thereof?

The ſum of the ſides is 44, the half-ſum is 22; the differences betwixt each ſide and that half, are 2, 9, 11; which Numbers rank in this Order following.

The half-ſum,	22	1,342423
The differences,	2	0,301030
	9	0,954243
	11	1,041393
The ſum of the Logarithms		3,639089
The Area or Content required,	66	1,819544

And this Area or ſuperficial Content thus found, is always of the ſame Nature with the ſides of the Triangle; that is to ſay, if the ſides of the Triangle be given in Feet, then is the content found in Feet: Alſo if the ſides be Perches you ſhall have the content in Perches; and ſo of any other Meaſure whatſoever.

Other Caſes might be added, but in this place at preſent let theſe ſuffice. And now I ſhall proceed to ſhew you the farther Uſe of theſe Tables and Lines, in the ſolution of divers Problems, which are of frequent Uſe in the Practice of Surveying.

TRIGO-

OF TRIGONOMETRY.

The Second PART.

THE Table of Logarithms, or Line of Numbers, are of ſingular Uſe in caſting up the Content of any *Superficies*, and for *Land-meaſuring* particularly. Mr. *Gunter* hath ſeveral Propoſitions, like unto which I will here inſert divers others, which will be of ſpecial Uſe in the Practice of *Surveying*; ſhewing you how they may be wrought both by the *Table of Logarithms*, and alſo by the *Line of Numbers*, on the edge of your Index.

PROBLEM. I.

The length and breadth of a Right-angled Parallelogram *being given in Perches, to find the Content thereof in Perches.*

IN the *Parallelogram* ABCD, (*fig.*5.) let the length AB be 25 Perches and the breadth A C 12, 8, that is, 12 Perches, and 8 tenth parts of a Perch, and the content in Perches is required. The proportion is,

As 1 Perch is to 12, 8, (the breadth in Perches)
So is 25 Perches (the length in Perches)
to 320, (the Content in Perches.)

By the Logarithms.

The Logarithm of 12, 8 is —— ——	1,107209
The Logarithm of 25 is ——	1,397940
Their ſum - - -	2,505149

which is the Logarithm of 320; and ſo many ſquare Perches are contained in the Parallelogram A B C D.

By the line of Numbers.

Extend the Compaſſes from 1 to 12, 8, the ſame extent will reach (the ſame way) from 25 to 320, the content in Perches, as before.

Or,

Extend from 1 to 25, it will reach from 12, 8 to 320.

PROB. II.

The length and breadth of a Parallelogram *being given in Perches, to find the Content in Acres.*

SO in the ſame Parallelogram A B being 25 Perches, and A C 12, 8 Perches, the proportion is,

As 160 (the Perches contained in one Acre)
is to 12, 8, (the breadth in Perches,)
So is 25 (the length in Perches)
to 2 (the content in Acres.)

By the Logarithms.

The Logarithm of 160 is - - - -	2,2041
The Logarithm of 12, 8 - - - -	1,1072
The Logarithm of 25 - - - -	1,3979
Their ſum - -	2,5052
The Log. of 160 being ſubtracted, there remains	0,3011

which

which is the Logarithm of 2; ſo that in the Parallelogram ABCD there is contained juſt 2 Acres.

By the line of Numbers.

Extend the Compaſſes from 160 (downwards) to 12,8, the ſame Extent will reach from 25 (downwards) to 2, the content in Acres.

PROB. III.

The length and breadth of a Parallelogram *being given in Chains, to find the Content in Acres.*

IN the Parallelogram ABCD, let the length thereof CD be 6 Chains, 25 Links, and the breadth thereof BD 3 Chains, 20 Links, to find the content thereof in Acres. The proportion is,

As 10 is to 3, 20 Links (the breadth)
So is 6 Chains 25 Links (the length)
to 2 (to the content in Acres.)

By the Logarithms.

The Logarithm of 10 is	1,000000
The Logarithm of 3, 20 is - - - -	0,505149
The Logarithm of, 6,25 is	0,795881
Their ſum is —	1,301030

From which 1,000000 being ſubtracted, there remains 0,301030, which is the Logarithm of 2; and ſo many Acres are contained in the Parallelogram ABCD.

In this Operation, and all others of the ſame Kind, where we uſe Chains and Links, we are to ſeek the Log of Chains and Links as tho' all were Links, and to leſſen the left-hand Figure (cut off by the Comma) by 2; that is, inſtead of 3 Chains, 20 Links, ſeek the Log of 320, which is 2,505149; and then leſſening the left-hand place by 2, it is, 0,505149. Or elſe uſing the Logarithms without leſſening them, in their ſum, leſſen the left-hand place by 4.

Or,

Or, Laſtly, cut off towards the right-hand, of the Number anſwering to the ſum, 4 places, and thoſe to the left are Acres.

PROB. IV.

The Baſe and Perpendicular of a Triangle being given in Perches, to find the Content in Acres.

IN the Triangle ECD (*fig.* 6.) let the Perpendicular EF be 38 Perches, and 4 tenth parts of a Perch and the Baſe CD 75 Perches; to find the content in Acres, this is the proportion,

As 320 is to 38, 4, (the Perpendicular)
So is 75 (the Baſe)
to 9 (the content in Acres.)

By the Logarithms.

The Logarithm of 320 is - - - - - -	2,505149
The Logarithm of 38, 4 is - - - - - - -	1,584331
The Logarithm of 75 is - - - - - - -	1,875061
Their ſum is	3,459392
From which 2,505149 being ſubtracted, there remains	0,954243

which is the Logarithm of 9; and ſo many Acres are contained in the Triangle ECD.

By the line of Numbers.

Extend the Compaſſes from 320 (downwards) to 38, 4, the ſame extent will reach (downwards) from 75 to 9, the quantity of Acres in the Triangle contained.

PROB.

PROB. V.

The Baſe and Perpendicular of a Triangle being given in Chains, to find the Content thereof in Acres.

SO in the former *Triangle*, the Perpendicular EF being 9 Chains, 60 Links, and the Baſe CD 18 Chains, 75 Links; to find the Content in Acres: The proportion is,

As 20 is to 9, 60, (the perpendicular,)
So is 18,75 (the Baſe) to 9 (the Content.)

By the Logarithms.

The Logarithm of 20 is - - - -	1,301030
The Logarithm of 9, 60 is - - - -	0,982271
The Logarithm of 18,75 is - - - -	1,273001
Their ſum is -	2,255272

From which 1,301030 (the Logar. of 20) being ſubtracted, there will remain 0,954242, which is the Logarithm of 9, the content of the Triangle in Acres.

¶ *Note*, Your Table of Logarithms in this Book going but to 1000, you cannot therein find the Logarithm of 18, 75, which is 1, 273001: wherefore, if (inſtead thereof) you take the Logarithm of 18, 7, (omitting the 5) which is 1, 271842, the Work will be near the ſame; for the Logarithm thereby produced, will be 0, 953083, which is the neareſt logarithm in your Table to 9, and ſo will produce the ſame Effect, as if you had had the Logarithm of 18, 75. And thus may you do if your Numbers were greater: As if the Baſe of a Triangle were 27 Chains, 81 Links, and the Perpendicular 12 Chains, 94 Links, the Area of that Triangle will be found to be 12 Acres, as by the Example, here wrought, may appear.

The Logarithm of 20 is				1,301030
The Log. of 27, 81, is	1,444201	instead of which I take the Logar. of	27,8	1,444045
The Log. of 12, 94 is	1,111934		12,9	1,110589
Their ſum is	2,556135	Their ſum is		2,554634
From both which ſubtract the Log. of 20, and there remains	1,255105	Or		1,253604

Either of which, in your Table, will be found to be the Logarithm of 18: And ſo many Acres are contained in ſuch a Triangle: Nevertheleſs it is much better to uſe a larger Table, ſuch as *Sherwyn*'s.

By the line of Numbers.

For the firſt Triangle, --- Extend the Compaſſes from 20 (downwards) to 9,60: The ſame Extent will reach from 18, 75 (downwards) to 9, the content of the Triangle in Acres.

For the ſecond Triangle, --- Extend the Compaſſes from 20 (downwards) to 12, 94: The ſame Extent will reach from 27, 81 (downwards) to 18, the content of that Triangle in Acres.

PROP. VI.

Having the length of the Furlong given, in Perches, to find the breadth of the Acre.

SO if a Furlong ſhould be 50 Perches long, and you would know what breadth it muſt be to make an Acre, this is the Rule.

As 50 (the length of the Furlong in Perches)
is to 160 Perches, conſtantly
So is 1 Acre
to 3, 2, (the breadth of the Acre in Perches)

By

By the *Logarithms.*

The Logarithm of 50 is - - - - - - - - -	1,698970
The Logarith of 160 is - - - - - - - - - - -	2,204119
The Logarithm of 1 is - - - - - - - - - - -	0,000000
The ſum - - -	2,204119
Subtract 1,698970, and there remains - - - -	0,505149

which is the Logarithm of 3,2 that is, 3 Perches, and 2 tenth parts of a Perch: and ſo broad muſt the Furlong be to make it juſt an Acre.

By the line of Numbers.

Extend the Compaſſes from 50 to 160, the ſame extent will reach the ſame way, from 1 to 3,20, the breadth of the Acre.

PROB. VII.

The length of the Furlong being given in Chains, to find the breadth of the Acre in Chain-meaſure.

SO if the Furlong be 6 Chains 56 Links long, or, 656 Links, how broad muſt it be to make an Acre? To perform which, this is the Rule,

As 656, (the length of the Furlong in Links)
is to 100000, a conſtant Number,
So is 1 Acre
to 153 Links, or 1 Chain 53 Links, (the breadth of the Acre in Chain-meaſure.)

By the *Logarithms.*

The Logarithm of 656 is - - - - - - - - -	2,816904
The Logarithm of the conſtant Numb. 100000, is	5,000000
The Logarithm of 1 is - - - - - - - - - - -	0,000000
Their ſum	5,00000
From which ſubtract 2,816904, there reſts, —	2,183096

which

which is the Logarithm of 153, that is, 1 Chain, 53 Links; and ſo broad muſt the Furlong be to make it an Acre.

By the Line of Numbers.

Extend the Compaſſes from 6, 56 (upwards) to 10; the ſame Extent will reach, the ſame way, from 1 to 1, 53 the breadth of the Acre in Chain-meaſure.

PROB. VIII.

The length or breadth of any piece of Ground *being given either in Perches, or Chains and Links, how to lay out any Quantity of Acres required, retaining ſtill the ſame breadth or length.*

SUppoſe HIKL (*fig.* 7.) were a piece of Land, the Side whereof from H to K were 9 Chains, 75 Links, and from that ſide I would lay out a Parcel which ſhould contain 7 Acres; how much breadth muſt be ſet off from H and K, towards I and L? To perform this, this is the Proportion;

As 9, 75 (the length or breath given)
is to 1,00000, (or 1 Acre)
So is 7, (the Number of the Acres required to be laid out)
to 7 Chains, 18 Links (the breadth.)

By the Logarithms.

The Logarithm of 9, 75 is - - - - - - -	0,989005
The Logar. of 1,00000 (or 1 Acre) is - - -	0,000000
The Logafithm of 7 is - - - - - - - -	0,845098
Their ſum the ſame---	0,845098
0,989005 being ſubtracted, there reſts - -	0,856093

which is the Logarithm of 7, 18, that is, of 7 Chains 18 Links: and ſo much being ſet off, or ſtaked out from H to M, and from K to N, and a Hedge, Pale, or Wall, made from M to N, it ſhall incloſe the piece of Land HMNK, containing juſt 7 Acres, as war required.

Hereof expect more in laying out Lands.

By

By the line of Numbers.

Extend the Compaſſes from 9,75 (the length or breadth given) to 7, (the quantity of Acres to be ſet out) the ſame Extent will reach from 1 Acre to 7, 18; that is, to 7 Chains, 18 Links: And ſo much being ſet from H and K towards I and L, as at M and N, the Hedge M N ſhall incloſe a piece containing 7 Acres.

PROB. IX.

The Area, or ſuperficial Content of any piece of Land being given, according to one kind of Perch, to find how much the ſame piece of Land would contain, if it were meaſured with a Pole or Perch of another length, differing from the former.

LIKE Plains are in proportion one to another, as are the Quadrats (or Squares) of their homologal Sides: And therefore,

As the ſquare of the Perch, by which the Land is to be meaſured,
is to the ſquare of the Perch, by which it was meaſured,
So is the Area given
to the Area required.

Thus; Suppoſe B (*fig.* 8.) be a piece of Land, (ſuppoſe a Wood) which being meaſured by a Chain of 18 Foot (which is the Wood-land Perch) ſhould contain 61 Acres, and 3 tenth parts of an Acre; and it were required to find how many Acres the ſame Land would contain, if it had been meaſured by a Chain of 16 Foot and an half to the Perch, (which is a Statute Perch) for ſeveral Countries have their reſpective Cuſtoms; but this Rule is general: To work it, this is the Proportion.

As the Square of $16\frac{1}{2}$, (the Perch by which the Land is to be meaſured) which is 272, 25,
is to the Square of 18, (the Perch by which the Land was meaſured) and is 32 4,
So is 61 3, (the Quantity as meaſured by the 18 Foot Perch)
to 73 (the Quantity, when meaſured by the Statute Perch of $16\frac{1}{2}$.

By the Logarithms.

The Logarithm of 272, 25 you cannot find in your Table: Wherefore (becauſe it is the Square of 16, 5) double the Logarithm of 16, 5, which is 1,217484, and it makes 2,434968, which is equal to the Logarithm of 272, 25; and ſo muſt you do in other the like Caſes. Now to proceed,

The Logarithm of 272, 25 is	2,434968
The Logarithm of 324 is	2,510545
The Logarithm of 61, 3, is	1,787460
Their ſum	4,298005
The firſt Number ſubtracted, there remains	1,863037

which is the Logarithm of 73: And ſo many Acres would the piece of Land have contained if it had been meaſured with a Chain of 16½ Foot in the Perch.

On the contrary, If this Piece being meaſured by a Chain of 16½ in the Perch, ſhould have contained 73 Acres, and it had been required to know how many Acres it would have contained, had it been meaſured by the Chain of 18 Foot in a Perch, the Operation would have been as followeth.

The Logarithm of 324 is	2,510545
The Logarithm of 16, 5 is	1,217484
The ſame again	1,217484
The Logarithm of 73 is	1,863323
Their ſum	4,298291
The firſt Number ſubtracted, there remains	1,787746

which is the Logarithm of 61, 3, which is 61 Acres and 3 tenth parts on an Acre: And ſo much doth the Land contain, if meaſured with an 18 Foot Pole.

By the line of Numbers.

This Work (by the Line of Numbers) is done more eaſily, for here is no need of ſquaring of the Feet in the Perches, but do thus;

For the firſt Example, ---- Extend the Compaſſes from 16, 5 to 18, the ſame extent will reach the ſame way from 61, 3 to another Number upon the Line; and from that other Number forward to 73; which is the Content, when meaſured by a Statute Perch.

For

For the ſecond Example, - - - Fxtend the Compaſſes from 18 (downwards) to 16, 5; the ſame extent will reach from 73 (downwards) to a fourth Number, and from that fourth Number, to 61, 3; and that is the Quantity, if it be meaſured by a cuſtomary Perch of 18 Foot.

PROB. X.

The Area or Content of any Plat of Land being given, (and the Scale loſt or concealed) to find the Scale by which the ſame Plat was plotted.

LET the Figure B (in the laſt Problem) be a Piece of Land ſaid to contain 8 Acres, and you deſire to know by what Scale it was plotted.

Firſt, Take any Scale, (as ſuppoſe that of 12 in the Inch) and caſt up the content of the Plat thereby, (as is hereafter taught in the Fourth Book;) and ſo doing, ſuppoſe you find the ſame Plat to contain 11 Acres, and 50 hundreth parts of an Acre, (that is, half an Acre) which ſhould by the Aſſertion be 12 Acres: Now, to find the true Scale by which it was plotted, this is the proportion;

As the quantity of Acres found (*viz.* 11, 5 Acres)
is to the Square of 12, the Scale by which you meaſured,
(*viz.* 144,)
So is the Content given (*viz.* 8 Acres)
to 100, the Square of the Scale by which it was plotted,
(*viz.* 10)

By the Logarithms.

The Logarithm of 11, 5 is	1,060698
The Logarithm of 144 is	2,158362
The Logarithm of 8 is	0,903090
Their ſum	3,061452
The firſt Logar. ſubtracted, there remains	2,000754

which is the Logarithm of 100, the Square Root whereof is 10; and that is the Scale by which the Plat was plotted. --- Or, when you have found the Logarithm 2,000754, you may take the half thereof, which is 1,000377, which will be the Logarithm of 10 alſo for the Scale required.

By the Line of Numbers.

Extend the Compaſſes from 11, 5 (downwards) to 8, the ſame extent will reach from 144 (downwards) to 10, the Scale by which the Plat was plotted as before.

Divers Problems of this Kind might be added, but theſe being moſt neceſſary, I ſhall trouble the Reader with no more at this time.

The Invention of Logarithms, *is one of the greateſt Improvements in* Mathematicks: *But becauſe this Table is ſhort, tho' ſufficient for a Surveyors* Trigonometry; *and, becauſe their full Uſe in caſting up Land, requires more Directions than I have Room here to give; alſo, becauſe Operations of this Kind are eaſily enough calculated by the Pen, I refer you to the Doctrine hereafter laid down.*

The End of the Third Book.

THE

THE COMPLEAT SURVEYOR.

The Fourth BOOK. In Two PARTS.

THE ARGUMENT.

IT hath hitherto been our business to provide necessary Instruments, *and to learn such things which of necessity ought to be known before we enter the Fields to* Survey. *Being thus provided, we come now to apply these* Instruments, *and other things before learned, to Practice, and that several ways: First, in taking of* Heights *and* Distances, *whether accessible or inaccessible; and then, in* Surveying *of* Land. *In this* Book *every kind of Work is perform'd Three several ways, by Three several* Instruments, viz. *the* Plain Table, *the* Theodolite, *and* Circumferentor; *by*

by which the Congruity and Harmony of the ſeveral Inſtruments *may eaſily be diſcerned. and the Truth of every* Example *may the better appear. Here are alſo divers ways of* Surveying *by one and the ſame* Inſtrument, *that is, to take the* Plot *of a* Field *ſeveral ways, and to Meaſure all kind of* Grounds *whatſoever, whether* Wood-land *or other. In the* Firſt Part *of this* Fourth Book *you are alſo Taught how to* Survey *by the* Theodolite, *or* Circumferentor, *by way of* Traverſe, (*as they do keep their account at* Sea) *whereby, when you have gone over your Work, you may* (*by examining your* Field-Book *only*) *know whether you have wrought right or not, before you begin to* Protract; *and if you find your Work* erroneous, *you may amend it before you go out of the* Field. *And there are alſo added in this* Edition *other manner of ways of* Surveying, *both exact and compendious. Here is alſo ſhewn how to take the* Plot *of a whole* Mannor, *to find the* content *or* quantity *thereof, and to keep your* account *in your* Field-Book, *after the beſt and moſt eaſie manner: With divers* Rules, Cautions, *and* Directions *neceſſary to be obſerved in that* Work. *You have alſo in this* Book *the manner how to lay out ſeveral* Furlongs *in* Common Fields, *and to incloſe a* Lordſhip *lying in* Common, *and to give a particular of all the* Arable Leys *and* Meadow-Grounds *in the ſame* Lordſhip: *Alſo how to* Plot *Mountainous and uneven Ground; with divers other matters and things pertinent to* Surveying, *which would be too tedious here to enumerate.*

The

The First PART.

The Application and Uſe of the ſeveral INSTRUMENTS (before deſcrib'd) in the Practice of SURVEYING.

CHAP. I.

The Uſe of the Scale.

HAving before deſcribed the ſeveral Inſtruments belonging to Surveying, I will now ſhew the Uſe of them: And firſt, of the *Scale*. The *Scale* is principally intended for the laying down of Lines; for which purpoſe the ſeveral Scales of equal Parts are there divided, ſome into greater and ſome into leſſer Quantities, but all of them into 10 Diviſions apiece; the uſe of all of them being the ſame. For each Line is divided into certain equal Parts repreſenting 8 Chains. And theſe grand Diviſions are numbred with Arithmetical Figures by 1, 2, 3. &c. to the end of the Ruler, upon which the Scales are deſcribed: And the uppermoſt large Diviſion is again divided into 10 other ſmaller Parts, every Part containing 10 Links of your Chain: Each of which ſmaller Parts, you may ſuppoſe to be again divided into 10 other leſſer Parts repreſenting ſingle Links of your Chain.

I *Any diſtance being meaſured by your Chain, how to lay down the ſame diſtance upon Paper.*

Suppoſe, that meaſuring along a Hedge, or the diſtance between any two marks or places, with your Chain, you find the length thereof to contain 5 Chains 60 Links: Now to take this diſtance from your Scale, and lay it down upon Paper, do thus. First,

Firſt, draw a Line, as A B: Then place one Foot of your Compaſſes upon your Scale at the Figure 5, for your five Chains, and extend the the other Foot to ſix of the ſmall Diviſions, (which repreſent the 60 Links:) Then ſet this diſtance upon the Line drawn from A to B. So ſhall the Line A B contain 5 Chains 60 Links, if you take the diſtance from the Scale of 10 in an Inch, which Scale hath 10 at the top thereof in large Figures.

But if you would have your Line ſhorter, and yet to contain 5 Chains 60 Links, then take your diſtance from a ſmaller Scale as of 12, 16, 20, or 24 in an Inch; ſo ſhall the 5 Chains 60 Links end at C, if taken from the Scale of 12 in an Inch, or at D, by the Scale of 16; or at E, by the Scale of 24: Either of which Lines will contain 5 Chains 60 Links, and be in proportion one to the other as the Scales from whence they were taken. And in this manner may any number of Chains and Links be taken from any of the Scales.

2 *A Right Line being given, to find how many Chains and Links are therein contained, according to any Scale aſſigned.*

Suppoſe A B were a Line given, and it were required to find how many Chains and Links are contained therein, according to the Scale of 10 in an Inch. Take in your Compaſſes the length of the Line A B, and applying it to your Scale of 10 in an Inch; you ſhall find the extent of the Compaſſes to reach from five of the great Diviſions, to ſix of the leſſer Diviſions: Wherefore the Line A B contains 5 Chains and 60 Links. The like muſt be done for any Line, and alſo by any of the other Scales.

¶ But here you muſt remember, that in laying down of the lengths of Lines by your Scales, whatſoever Scale you begin your Work with, with the ſame Scale you muſt continue it to the end, not laying down one Line by one Scale, and another by another. But if you would have a large Work in a little room, then uſe a ſmall Scale, as of 24 or 30 in an Inch: But on the contrary, if you would expreſs every ſmall particular, then you were beſt to uſe a larger Scale, as of 10 or 12 in an Inch.

There is another kind of Scale called a *Diagonal*, conſiſting of 11 Parallel Lines, one of which is divided and Numbred as the preceeding Scales; with this Addition, *viz.* the ſame Diviſions which repreſent the tens of Links, or, 10th Parts of the Chain, are Numbred 2, 4, 6, 8; and the uſe of this Line is in all reſpects the ſame with thoſe before mentioned; ſo that 5 Chains 60 Links are taken from the grand Diviſion, Numb. 5, to the ſmall Diviſion Numb. 6.

The

The other 10 Lines are to give the Length when there are any odd Links beſides the Tens, and every other of theſe Lines are Number'd at the Ends 2, 4, 6, 8; and thoſe between them are only conceived to be Numb. 1, 3, 5, 7, 9, for want of Room.

If by this Scale you would take 5 Chains 64 Links, take from the long Line markt 4 at the End, the Diſtance from the grand Diviſion markt 5, to the leſſer Diviſion markt 6, and that will repreſent 5 Chains 64 Links; and if you would have 7 Chains 59 Links, on the long Line markt 9 at the End, take the Diſtance from the grand Diviſion markt 7, to the leſſer Diviſion markt 5, you will have the Repreſentative of 7 Chains and 59 Links.

And every of theſe Diagonals are double, one End being a Scale twice as great as the other: But here we may obſerve, That a Diagonal Scale generally fills up one ſide of a Ruler, and can give us but 2 Sizes of Scales, and therefore, though it be very exact, yet is not ſo general as the preceeding.

There is yet one kind of Scale, which for Neatneſs, Eaſe and Diſpatch, exceeds all thoſe mentioned; its Deſcription and Uſe will be in the Appendix.

Upon the Rular there is (beſides the ſeveral Scales of equal parts) a Line or Scale of Chords, which is numbred by 10, 20, 30, *&c.* to 90, and this line ſerveth to protract or lay down Angles. But in all the practice of Surveying, a *Protractor* is much more convenient; yet for other uſes, this line may be very ſerviceable, and when a *Protractor* is wanting, it may ſupply that defect. The manner how to uſe it is thus.

3. *How to lay down upon Paper an Angle containing any number of degrees and minutes, by the line of Chords.*

Draw a line at pleaſure, as AB, (*Fig.* 16) and from the point A, let it be required to protract or lay down an angle of 40 deg. 20 min.

Firſt, extend your Compaſſes upon the line of Chords, from the beginning thereof, to 60 degrees always, and with this diſtance; ſetting one foot upon the point A, with the other deſcribe the arch BC: Then with your Compaſſes take 40 degrees 20 minutes (which is the quantity of the angle which is to be laid down) out of the line of Chords, from the beginning thereof to 40 degrees 20 minutes; then (the Compaſſes ſo reſting) if you ſet one foot thereof upon B, the other will reach upon the Arch to C: Laſtly, draw the line AC, ſo the angle CAB ſhall contain 40 degrees 20 minutes.

4. *Any Angle being given, to find what number of degrees and minutes it containeth.*

Suppoſe CAB (*Fig.* 16) were an Angle given, and that it were required to find the quantity thereof. Open your Compaſſes (as before) to 60 Degrees of your Chord, and placing one Foot in A, with the other deſcribe the Arch CB: Then take in your Compaſſes the diſtance CB, and meaſuring that extent upon the line of Chords, from the beginning thereof, you ſhall find it to reach to 40 degrees 20 minutes; which is the quantity of the required Angle.

If any Angle given or required ſhall contain above 90 Degrees, you muſt then protract it at twice, by taking firſt the whole line, and then the remainder, or dividing the Angle into any two parts equal unto it, as if the Angle were 159 Degrees; take 80 and 79 deg. or 90 and 69 deg. *&c.* or rather by taking 60 or twice 60 (if the Angle be ſo much) and then the Remainder.

CHAP. II.

Of the Uſe of the Protractor.

ALthough the chief Uſes of the *Protractor* may be performed by the line of Chords laſt ſpoken of, yet for avoiding ſuperfluous Lines and Arches (which muſt otherwiſe be drawn all over your Paper upon which you protract your Plot) the *Protractor* is far more convenient; the Uſe whereof is,

1. *To lay down upon Paper an Angle of any quantity, ſuppoſe* 50 *Degrees.*

Firſt, draw a right Line at length, as AB: (*Fig.* 17) then on any part thereof, as on C, place the Center of the *Protractor*; in which point alſo fix your Protracting-pin, and turn the *Protractor* about upon the Center, till the Meridian-line or Diameter of the *Protractor* (noted in the Deſcription thereof with EF) lie directly on this line AB, the Semicircle of the *Protractor* lying upwards, (or from you:) then holding with your Left-hand the *Protractor* faſt there, with your Protracting-pin cloſe to the edge of the Semicircle of the *Protractor*, at the diviſion of 50 Degrees, mark the point D with your Protracting-pin, and draw the line CD. So ſhall the Angle DCA contain 50 Degrees.

Here we may obſerve, that the *Protractor* here ſpoken of, is numbred from A towards B, according to the motion of the Sun, and agreeing to the Numbring on the *Theodolite*; and therefore, as in this Example, it lays down an Angle, whoſe Angular-point is towards

wards the Right-hand. But if the line CB were given, and it were required to draw ſome line towards DC, contrary to (the motion of the Sun) and the numbring of the *Protractor*, that ſhall make an Angle with CB at C of any aſſigned Number of Degrees, ſuppoſe 130; lay the Center on C, and turn the *Protractor* about 'till 130 fall on CB, and then with your *Protracting-pin* make the mark D at the beginning of the Diviſions, and draw DC. So ſhall the Angle DCB be 130 Degrees.

Or rather thus: Subſtract 130 from 180, and of the Remainder 50 Degrees make an Angle ACD, and then will DCB be 130, becauſe both will always make 180.

2. *Any Angle being given, to find the quantity thereof by the* Protractor.

Suppoſe DCB (*Fig.* 17) were an Angle given, and that it were required to find the quantity thereof by the *Protractor*. Firſt, you muſt apply the Center of the *Protractor* to the point C, and the Meridian line or Diameter thereof directly upon the line DC; then ſhall you find the line CB to lie directly under 130 Degrees of the *Protractor*, and ſuch is the quantity of the Angle DCB required; but here we are to Obſerve, that the line DC muſt be produced till it reach both ways to the Arch of the *Protractor*, in order to guide the laying the Diameter exactly on it.

CHAP. III.

Of the Plain Table, *how to ſet the parts thereof together, and make it fit for Uſe in the Field.*

WHen you would make your Table fit for Uſe in the Field, lay the three Boards thereof together, and alſo the ledges at each end thereof in their due places, according as they are marked. Then lay a ſheet of white Paper all over the Table, which muſt be ſtretched over all the Boards, by putting on the Frame, which binds both the Paper to the Boards, and the Boards one to another. Then ſcrew the Socket on the back-ſide of the Table, and alſo the Box and Needle in its due place, the Meridian line of the Card (which is in the Box) lying parallel to the Meridian or Diameter of the Table; which Diameter is a right line drawn upon the Table, from the beginning of the degrees through the Center, and ſo to the end of the degrees. Then put the Socket upon the head of the Staff, and there ſcrew it: Alſo put the Sights upon the Index, and lay the Index upon the Table. So is your Inſtrument prepared for uſe as a *Plain Table* or *Theodolite*, the difference only being in placing of the Index: For when you uſe your Inſtrument as a *Plain Table*, you may pitch your Center in any part of the Table, which you ſhall

shall think most convenient for the bringing on of the Work which you intend; but if you use your Instrument as a *Theodolite*, then the Index must be turned about upon the Center of the Table; for which purpose there is a piece of Wire which goes through a small hole of Brass fastned to the Index, and so into the Center, by which means the Index keeps his constant place, only moving upon the Center.

Your Instrument being thus ordered, you may use it either as a *Plain Table* or a *Theodolite*: But if you would use it as a *Circumferentor*, you need only screw the Box and Needle to the Index, and both of them to the head of the Staff, with a brass Screw-pin fitted for that purpose; so that the Staff being fixed in any place, the Index and Sights may turn about at pleasure without moving of the Staff. And now is your Instrument a good *Circumferentor*, nay better then that before described in the Second Book.

Also, when you have occasion to measure any Altitude, hang the Label upon the farther Sight: And thus are you exactly fitted for all occasions.

CHAP. IV.

How to measure the quantity of any Angle in the Field by the Plain Table, Theodolite, *and* Circumferentor: *and also to observe an Angle of Altitude.*

YOU must understand, that when I mention the *Plain Table*, or perform any work thereby, that I mean the Table when it is covered with a sheet of Paper, upon which all Observations of Angles that are taken upon the Table in the Field, do agree exactly in Proportion with those of the Field it self, but are not denominated by their quantities, but by their Symmetry or Proportion.

Secondly, when I mention the *Theodolite*, or work by that Instrument, I do not mean the *Theodolite* before described in the 2 *Chapter* of the 2 *Book*; but I mean the Degrees described on the Frame of the Table, which supplies the Use thereof.

Thirdly, when I mention or make use of the *Circumferentor*, I mean the Index with the Box and Needle screwed to the Staff.

¶ *Having thus given you a sufficient Description of the several Instruments and their Parts, I come now to the Use of them, shewing how any Angle in the Field may be measured by any of them.*

How

How to obſerve an Angle in the Field by the Plain Table, Theodolite *and* Circumferentor.

I. *By the* Plain Table.

SUppoſe EK and KG (*Fig.* 18) to be Hedges, or two ſides of a Field, including the angle EKG, and that it were required to draw upon your Table an angle equal thereunto. *Firſt*, place your Inſtrument as near the angular point K as conveniency will permit, turning it about, 'till the North-end of the Needle hang directly over the Flower-de-luce in the Box, and then ſcrew the Table faſt. Then upon your Table, with your Protracting-pin, or Compaſs point, aſſign any point at pleaſure upon the Table, and to that point apply the edge of the Index, turning the Index about upon that point, 'till through the Sights thereof you eſpie a mark ſet up near E, but as far from EK as the Inſtrument near K is from EK; and then with your Protracting-pin, or Compaſs point, or Black lead, draw a line by the ſide of the Index to the aſſigned point upon the Table. Then (the Table remaining immoveable) turn the Index about upon the ſame point, and direct the Sights to a mark ſet up at G, or parallel thereto, that is, ſo far diſtant from GK as your Inſtrument is placed from KG, and then by the ſide of the Index, draw another line to the aſſigned point. So ſhall you have drawn upon your Table two lines, which ſhall repreſent the two hedges EK and KG; and thoſe lines ſhall include an Angle equal to the Angle EKG. And although you know not the quantity of this Angle, yet you may (by the 1. or 2. *Chapters* of this *Book*) find the quantity thereof, if there were any need: For in working by this Inſtrument, it is ſufficient only to give the ſymmetry or proportion of Angles, and not their quantities, as in working by the *Theodolite* or *Circumferentor* it is. Alſo in working by the *Plain Table* there needeth no Protraction at all, for you ſhall have upon your Table the true figure of any Angle or Angles which you obſerve in the Field, in their true poſitions, without any farther trouble.

Here Note, That when I ſay plant your Inſtrument at any Angle, I mean, as near that Angle as you can conveniently come; and when I ſay direct to any Mark in any other Angle, I mean, a Mark ſet up near the Angle equidiſtant from the Hedge with the Inſtrument.

II. *By the* Theodolite.

LET it be required to find the Quantity of the Angle EKG by the *Theodolite*. Place your Inſtrument at K, laying the Index on the Diameter thereof; then turn the whole Inſtrument a-

bout, (the Index ſtill reſting on the Diameter) 'till through the Sights you eſpie the Mark at E; then ſcrewing the Inſtrument faſt there, turn the Index about upon the Center, 'till through the Sights you eſpie the Mark at G; then note what Degrees (on the Frame of the Table) are cut by the Index, which you will find to be 114 Degrees, and that is the Quantity of the Angle EKG.

One thing is to be Obſerved, That when you look on the Diviſions of *Theodolite*, which are on the neareſt edge to you; in ſome the Numbers encreaſe towards the left hand, in others towards the right: And this is the firſt thing to be obſerved, if you meet with an Inſtrument you never ſaw before.

And then ſtanding at the Inſtrument to take your Obſervation, if the Degrees encreaſe towards the left hand, the fixt Sights ſhall be directed along EK the left hand Hedge, if otherwiſe the contrary.

III. *By the* Circumferentor.

IF it were required to find the Quantity of the former Angle EKG (*Fig.* 18) by the *Circumferentor*; *Firſt*, place your Inſtrument (as before) at K, with the Flower-de-luce in the Card towards you; then direct your Sights to E, and obſerve what Degrees in the Card are cut by the South-end of the Needle, which let be 296: Then turning the Inſtrument about upon the Staff (the Flower-de-luce always towards you) direct the Sights to G, noting then alſo what Degrees are cut by the South-end of the Needle, which ſuppoſe 182. This done (always) ſubtract the leſſer number of Degrees out of the greater, as in this Example 182 from 296, and the Remainder is 114 Degrees; which is the true Quantity of the Angle EKG.

Again, The Inſtrument ſtanding at K, and the Sights being directed to E, as before, ſuppoſe that the South-end of the Needle had cut 79 Degrees; and then directing the Sights to G, the ſame end of the Needle had cut 325 Degrees: Now, if from 325 you ſubſtract 79, the Remainder is 246. But becauſe this Remainder 246 is greater than 180, you muſt therefore ſubtract 246, the Remainder from 360, and there will remain 114, the true Quantity of the inquired Angle. And thus you muſt always do, when the Remainder exceedeth 180 Degrees.

¶ This adding and ſubtracting for the finding of Angles, may ſeem tedious to ſome; but here the Reader may take Notice, That for quick diſpatch, the *Circumferentor* is as good an Inſtrument as the beſt. For in going round a Field, or in Surveying of a whole Mannor, you are not to take Notice of the Quantity of any Angle, but only to Obſerve what Degrees the Needle cutteth, which in thoſe caſes is ſufficient, as will appear hereafter: But in taking of Diſtances by the *Circumferentor*, it is altogether neceſſary, as may appear by the 7 *Chapter* following; and for that reaſon I have here ſhewed how to find an Angle by the *Circumferentor*, and alſo that you might thereby perceive

ceive what Congruity and Harmony there is in all the three Instruments.

And here we are to Observe, That the *Circumferentor* is the only Instrument proper to the Mapping of Harbours, and drawing the true Positions of Rocks, Lands, Shoals, Soundings, *&c.* nor is it scarcely possible to be done by any other Instrument; but such as have a Needle and divided Card. But of this more in the Appendix.

IV. *How to set the* Index *and* Label *Horizontal upon the* Staff.

WHen you have screwed the Index and Sights to the Staff as a *Circumferentor*, before you put the Label upon the Brass pin or Wire, you must hang a Line and Plummet upon that Pin, and then put on the Label; then move the Index up and down, 'till the Thred and Plummet hang directly upon a Line which is gaged from under the Pin all along the Sight; and then doth the Instrument stand Horizontal or Level, which it must always do when you take an Altitude therewith.

V. *How to observe an Angle of Altitude.*

THe Label which is to be hanged on one of the Sights of the *Circumferentor*, (as was intimated in the Description thereof) and the Tangent-line on the edge of the Index, is only for the finding of angles of Altitude, and is therefore only useful in taking of Heights, and in Surveying of Mountainous and uneven Grounds.

The manner how to observe an angle of Altitude by this Label and the Tangent-line on the Index, is thus.

Suppose CA (*Fig.* 19) to be a Tree, Tower or Hill, whose Height is required. Your Instrument being placed at B, exactly level, direct the Sights thereof towards CA, and there fix it, hanging the Label on the farthest Sight, on a Pin for that purpose: Then move the Label too and fro along the side of the Index, 'till through the Sight at the end of the Label, and by the Pin on which the Label hangeth, you espie the very top of the Object to be measured at C; then note what Degree of the Tangent-line is cut by the Label, which suppose 30, and that is the Quantity of the angle of Altitude, it being equal to the angle CBA.

Thus by the Rules in this Chapter delivered, may the true quantity of any Angle be easily taken; and this is the most convenient Use to be first placed. I will now shew how by your several Instruments you may take all manner of Heights and Distances, whether accessible or inaccessible, several ways, with divers other necessary conclusions incident to Surveying.

CHAP.

CHAP. V.

How to take an Inacceſſible Diſtance at two ſtations, by the three fore-mentioned Inſtruments; and firſt by the Plain Table.

YOU are taught in the laſt Chapter how to make Obſervation of any Angle in the Field by the ſeveral Inſtruments before mentioned, as the *Plain Table*, *Theodolite* and *Circumferentor*; and alſo an angle of Altitude by the Index, and the Label thereunto annexed. I conceive it now convenient to ſhew how all manner of Heights and Diſtances may be readily and exactly meaſured ſeveral ways, whether they be acceſſible or inacceſſible. And firſt of Diſtances.

¶ You may remember that I formerly intimated, that the meaſuring of a Height or Diſtance is only to reſolve a Triangle; ſo that when you make any Obſervation either of Height or Diſtance, the Obſervation of Angles which you make are the Angles of ſome Triangle, and the lines which you meaſure on the Ground are the ſides of the ſame Triangle, and theſe are the given parts of the Triangle.

The manner how to take a Diſtance by the *Plain Table*, is thus: Suppoſe you were ſtanding in a Field at R, (*Fig.* 20) and that at S were ſome eminent Mark, (as a Tree, Church, Houſe, or ſuch like) and that it were required to find the Diſtance between R and S.

Firſt, place your Table at R, and thereon aſſign any Point at pleaſure, unto which Point apply the edge of your Index, turning it about upon that Point, 'till through the Sights you eſpie the mark at S, and draw a line by the ſide of the Index, as R S.

Then in ſome other convenient place of the Field (as at Q) let a Staff or other Mark be erected, and the Table remaining as before, turn the Index about upon the Point R, 'till through the Sights you eſpie the mark at Q, drawing a line by the ſide thereof, as R Q; ſo have you deſcribed upon your Table an angle equal to the angle Q R S. Then (with your Chain) meaſure the diſtance Q R, which let be 176 foot; then take with your Compaſſes 176 out of any Scale, and ſet it upon your Table from R to Q; ſo ſhall this point Q upon your Table repreſent the mark at Q in the Field.

This done, ſet up a Staff at R, where your Inſtrument ſtood, and remove your Table to Q, laying the Index upon the line Q R, and holding it faſt there, turn the whole Table about, 'till through the Sights you eſpie the mark ſet up at your former place of ſtanding at R; then ſcrew the Table faſt, and lay the Index on the point Q, turning it about upon the point Q, 'till through the Sights you

eſpie

eſpie the mark at S; then draw a line by the ſide of the Index which will cut the line R S (firſt drawn) in the point S.

By this means ſhall you have upon your Table a Triangle equal to the Triangle Q R S, the correſpondent ſides and angles thereof being proportionally equal with thoſe in the Field. Therefore, if with your Compaſſes you take the length of the ſide R S, and apply that diſtance to the ſame Scale from whence you took the ſide Q R, you ſhall find it to contain 400 Foot, and that is the diſtance between R and S. Likewiſe, if you take with your Compaſſes the length of the line Q S, and apply it to the ſame Scale, you ſhall find it to contain almoſt 303; and ſo many Foot is the diſtance Q S.

¶ In this manner may the diſtance between any two places be meaſured, although they be ſo Situated, that by reaſon of Water or other Impediments you cannot approach near unto them. And here Note, That when you take your ſecond Station, you take it ſo large if the Ground will permit, that the angle S may approach to 90 Degrees; for the nearer S is to 90 Degrees, the more directly will the point of Interſection be found.

CHAP. VI.

How to take an inacceſſible diſtance at two ſtations by the Theodolite.

IN the former Diagram, let R and Q (*Fig.* 20) be two Stations, from either of which it is required to find the diſtance to S.

Firſt, place your Inſtrument at R, laying the Index and Sights upon the Diameter thereof, turning the whole Inſtrument about, 'till through the Sights you eſpie your ſecond Station at Q, and there ſcrew it faſt; then turn the Index about upon the Center, 'till through the Sights you eſpie the Mark at S, noting the Degrees cut by the Index, which ſuppoſe 45 degrees 10 minutes; then remove your Inſtrument to Q; laying the Index on the Diameter thereof, and holding it there, turn the whole Inſtrument about, 'till through the Sights you eſpie your Mark at S; and fixing the Inſtrument there, turn the Index about, 'till through the Sights you ſee the Mark ſet up at your former Station at R, noting the Degrees there cut, which let be 110 deg. 30 min. This done, meaſure the diſtance of your two Stations Q R, which let be 176 Feet: So in the Oblique-angled Triangle Q S R you have given, (1) the angle S R Q, 45 deg. 10 min. the angle obſerved at your firſt Station; (2) the angle R Q S, 110 deg. 30 min. which was the angle obſerved at your ſecond Station; and (3) you have given the meaſured ſide R Q S 176 Foot, which is the diſtance of your two Stations, and you are to find the two other ſides R S, and Q S, which you may find by the 7 *Caſe* of the 4 *Chapter* of the 3 *Book*, in this manner. For,

Having two angles S R Q and R Q S given, you have alſo the third angle R S Q given, 24 degrees 20 minutes, it being the complement of the other two to 180 degrees, (by the 17 *Chap.* of the 3 *Lib.*) Then to find the other two ſides, the proportion is,

I. For the ſide Q S;

As the ſine of the angle R S Q, 24 degrees 20 minutes,
is to the Logarithm of the ſide R Q, 176 foot,
So is the ſine of the angle Q R S, 45 degrees 10 minutes,
to the Logarithm of the ſide Q S, 303 foot, *fere.*

II. For the ſide R S;

As the ſine of the angle Q R S, 45 degrees 10 minutes,
is to the Logarithm of the ſide Q S, 303 foot,
So is the ſine of the angle R Q S, 110 deg. 30 min. (or 69 deg. 30 min.) to the Logarithm of the ſide R S, 400 foot; which is the diſtance required.

¶ I have been larger upon this Particular then I intended, having ſufficiently inſiſted thereon before in the Dimenſion of plain Triangles; but that the Reader may fully underſtand theſe neceſſary concluſions, I have in this Example uſed all the perſpicuity I could imagine, ſo that in the ſubſequent Chapter I may be the Briefer; for this being well underſtood, he may eaſily apprehend any of the other at the firſt View.

CHAP. VII.

How to take an inacceſſible diſtance at two ſtations by the Circumferentor.

LET it be required to find the diſtance from R or Q to S. (*Fig.* 20.) *Firſt*, place your Inſtrument at R, and direct the Sights to S, obſerving what degrees the South-end of the Needle cutteth, which let be 315 deg. 30 min. then turning the Inſtrument about, direct the Sights to Q, obſerving what degrees the Needle there cutteth, which let be 270 deg. 20 min.; therefore from 315 deg. 30 min. ſubtract 270 deg. 20 min. and there will remain 45 deg. 10 min. which is the quantity of the angle S R Q.

Then remove the Inſtrument to Q, and direct the Sights to R, the Needle cutting 90 deg. 20 min.; alſo direct the Sights to S, the Needle cutting 339 deg. 50 min. Now if you ſubtract 90 deg. 20 min. from 330 deg. 50 min. the remainder is 249 deg. 30 minutes, which (becauſe it exceedeth 180 deg.) ſubtract from 360 deg. and there remains 110 deg. 30 min. the true quantity of the angle R Q S.

Having

Having thus obtained the two angles R Q S and S R Q, you muſt meaſure the Stationary diſtance Q R 176 foot; ſo have you given in the Triangle Q R S, (1) the angle R Q S, 110 deg. 30 minutes; (2) the angle Q R S, 45 deg. 10 min. (3) the angle Q S R 24 deg. 20 min. the complement of the other two to 180 deg. and (4) the Stationary diſtance Q R 176 foot, whereby you may find the other ſides Q S and R S, according to the Doctrine delivered in the foregoing Chapter.

	deg.	*min.*
First Station at R, degrees cut are	315	30
	270	20
The quantity of the Angle Q R S	45	10
Second Station at Q, degrees cut are	339	50
	90	20
Subſtract	249	30
from	360	00
The quantity of the Angle R Q S	110	30

The Stationary diſtance 176 Foot.

Having theſe things given, if you reſolve the Triangle Q R S, you ſhall find the ſide R S to contain 400 Foot, and the ſide Q S 303 Foot *fere*, as in the laſt Chapter.

CHAP. VIII.

How to protract or lay down upon Paper or Parchment a Diſtance taken, according to the directions of the two laſt Chapters, by help of your Protractor *or line of Chords.*

HAving made Obſervations in the Field by the *Theodolite* or *Circumferentor*, you are to note down the Quantities of the ſeveral Lines and Angles obſerved in the Field in a Book or Paper, ſo that they may be ready at hand when you come to Protraction; and this is the uſual way.

Suppoſe it were required to draw upon Paper or Paſtboard the true Symmetry or Proportion of the diſtance taken in the laſt Chapter.

Firſt, Upon your Paper draw a Line at length, as R Q, (*Fig.* 20) then, upon one end thereof, as at R, place the Center of your *Protractor*, and lay the Meridian line E F of the *Protractor* directly upon the Line Q R; then (becauſe the angle Q R S is 45 degrees 10 minutes,

10 minutes,) therefore againſt 45 degrees 10 minutes of your *Protractor*, make a Mark upon your Paper with your *Protracting-Pin*, (as is before taught *Chap.* 2) and draw the Line R S. This done, from any Scale, take your Stationary Diſtance R Q 176 Foot, and ſet it from R to Q: Then upon the point Q (becauſe the Angle R Q S contains 110 deg. 30 min.) place the Center of the *Protractor*, and turn it about 'till the Line R Q lie directly under 110 degrees. Then (at the point E of the *Protractor*) make a Mark with your *Protracting-Pin*, and through that point draw the Line Q S, which will cut the Line R S in the point S. Then if you meaſure the length of the Lines Q S and R S by the ſame Scale from whence you took 176 for the Line Q R, you ſhall find the Line Q S to contain 303, and the Line R S to contain 400, exactly agreeing with the number found in the laſt Chapter.

CHAP. IX.

How to take the Altitude of any Tower, Tree, Steeple, or the like, (being acceſſible) by the Label and Tangent-Line.

HAving in the fifth *Section* of the fourth *Chapter* of this *Book* ſhewn how to obſerve an Angle of Altitude by the Label and Tangent-line, we now come to the farther uſe thereof, in the taking of Heights, either Acceſſible or Inacceſſible.

Suppoſe therefore that the Line C A (*Fig.* 19) were a Tree, Tower, Steeple, or other thing, whoſe Height were required.

Firſt, place your Inſtrument at any convenient diſtance from the Baſe or Foot of the Object to be meaſured, as at B, and there looking through the Sight of the Label by the Pin, 'till you eſpie the top of the Altitude at C, note what degrees of the Tangent Line are cut by the Label; for that is the quantity of the Angle of Altitude, namely, the angle C B A, which ſuppoſe 30 degrees: Then is the other angle B C A 60 degrees, it being the Complement of the former to 90 degrees.

Then (with your Chain, or otherwiſe) meaſure the diſtance from B (the place of your ſtanding) to A, (the foot of the thing to be meaſured) which ſuppoſe 400 Foot.

Then in the Triangle A B C there is given (1) the Angle C B A 30 degrees; (2) the angle B C A 60 degrees; and (3) the diſtance B A 400 Foot: And it is required to find the ſide C A, by the 1 *Caſe* of Right-angled plain Triangles. For,

As the ſine of the angle B C A 60 degrees,
is to the Logarithm of the ſide B A 400 Foot,
So is the ſine of the angle C B A 30 degrees,
to the Logarithm of the ſide C A.

This

This Proportion being wrought according to the former directions, the ſide C A will be found to contain almoſt 231 Foot; and that is the Height of C A required.

CHAP. X.

How to Protract or lay down upon Paper the Obſervation made in the laſt Chapter.

HAving drawn a Line upon your Paper, as A B, place the Center of the *Protractor* upon B: Now (becauſe when you made your Obſervation at B, the Degrees cut were 30) turn the *Protractor* about, 'till the Line B A lies juſt under 30 Degrees; then (with your *Protracting-pin)* make a mark by the edge of your *Protractor* againſt 00 degrees, and draw the Line B C, ſo ſhall the angle C B A contain 30 degrees. Then, (becauſe the meaſured diſtance B L was 400 Foot) take 400 from any of your Scales of equal parts, and ſet that diſtance from B to A, and from the point A erect the Perpendicular A C; which Perpendicular being taken in your Compaſſes, and meaſured upon the ſame Scale from whence the 400 Foot was taken, you ſhall find it to contain almoſt 231 Foot: And ſo much is the Altitude C A, as before.

CHAP. XI.

How to take an inacceſſible Altitude by the Label and Tangent-Line.

FOR the effecting hereof, you muſt make two Obſervations with your Inſtrument. Let the Line B C (*Fig.* 21) repreſent ſome Object whoſe Height is required. *Firſt*, place your Inſtrument at A, and direct the Sights to B, the top of the Object: Noting what degrees of the Tangent-Line are cut by the Label, which let be 50 degrees, the quantity of the angle B A C. Now, becauſe you cannot come to meaſure the diſtance from A to C, by reaſon of ſome River or other impediment lying between A and C, therefore, with your Chain, meaſure out from A towards C any number of feet, according as the ground will permit, as from A to D, which ſuppoſe to be 200 Foot; and at D place your Inſtrument again, and there Obſerve the quantity of the angle B D C, which ſuppoſe to be 64 Degrees. Theſe two angles being known, the two oppoſite angles are alſo known: For the angle B A C being 50 degrees, the whole angle A B C muſt be 40 degrees, the Complement of the former to 90 degrees: Again, the angle B D C being 64 degrees, the angle D B C muſt be the Complement thereof, namely 26 de-

grees. Then if you subſtract the angle D B C, 26 degrees from the whole angle A B C, 40 degrees, there will remain 14 degrees for the angle A B D, by the knowledge whereof you may attain to the Altitude B C; for in the Triangle A B D you have given,

1 The Angle B A D, 50 degrees;
2 The Angle A B D, 14 degrees;
3 The Diſtance A D, 200 foot.

which (by the former Directions) will help you to find the length of the ſide D B, either by the Tables in the third Book, or by the Lines of Artificial Numbers, Sines and Tangents on the Index of your Table, as is formerly taught; the Proportion being,

As the Sine of the Angle A B D, 14 degrees,
is to the Logarithm of the ſide A D, 200 foot,
So is the Sine of the Angle B A D, 50 degrees,
to the Logarithm of the ſide D B:

which, by working according to the former direction, will be found to be 633 Foot.

Then muſt you make a ſecond work in the Triangle B C D, in which you have given,

1 The Angle B D C, 64 degrees;
2 The Angle D B C, 26 degrees;
3 The ſide D B, 633 Foot.

And you are to find the ſide of B C, the Altitude required: Wherefore ſay again,

As the Sine of the Angle B C D, 90 degrees,
is to the Logarithm of the ſide D B, 633 foot,
So is the Sine of the Angle B D C, 64 degrees,
to the Logarithm of the Altitude B C:

which, according to the former Doctrine, will be found to be 569 Foot, the Altitude required.

CHAP.

CHAP. XII.

How to Protract the Observation taken in the last Chapter.

HAving made observation as in the last Chapter, and noted down in a Book, or otherwise, that the degrees cut at your first Station at A (*Fig.* 21) were 50, and the degrees cut at the second Station at D were 64, and that your Stationary distance A D was 200 foot, you may immediately find the Altitude B C by Protraction, thus:

First, draw a Line, as A C, in which line let A represent your first Station, whereon lay the Center of your *Protractor*; and make the angle B A C to contain 50 deg. (as hath been several times before shewn) and draw the line A B. Then upon the line A C set off the distance of your two Stations, 200 foot, from A to D: Then bring your *Protractor* to D, (which represents your second Station) and placing the Center of your *Protractor* thereupon, set off an angle of 64 degrees, as B D C, and draw the line D B: Then where these two lines A B and D B intersect or meet, which is in the point B, from that point let fall the Perpendicular B C, the length whereof being measured upon the same Scale from whence you took the distance A D, will give you 569 foot; and that is the Altitude of A B, which was required.

CHAP. XIII.

How to take the Distance of divers places one from another, according to their true Situation, and to make a Map thereof.

I. *By the* Plain Table.

Fig. 1. THis Proposition is of good use to describe *in Plano* the most eminent places in a Town or City, and to make (as it were) a Map thereof. Let A B C D E F G be certain eminent places situate in some Town or City, and let it be required to describe all those places upon Paper, by which the Distance of any of them one from another may be readily found.

At some convenient distance from the City or Town, make choice of two convenient places, as K and L, from either of which you may plainly discern all the places which you intend to describe in your Map. Then at one of these places (as at K) place your Table, and near one of the sides thereof draw a Line parallel to the edge of the Table. In this Line assign any point, as K, for your

your first Station; and laying the Index upon the Line, turn the Table about, 'till through the Sights you espie the other place which you intend for your second Station; which found, screw the Table fast there.

Then laying the Index to the point K, turn it about, 'till through the Sights you espie your first mark at A, and by the side of the Index draw the Line A K: *Secondly*, turn the Index to the second mark at B, and draw the Line B K: *Thirdly*, direct your Sights to C, and draw the Line C K: *Fourthly*, direct your Sights to D, and draw the Line D K: *Fifthly*, direct the Sights to E, and draw the Line E K: *Sixthly*, direct the Sights to F, and draw the Line F K: *Lastly*, direct the Sights to G, and draw the line G K. So have you finished your work at your first Station.

This done, with your Chain measure the Distance of your two Stations K and L, (in which you must be very exact) which suppose to contain 800 Foot; and removing your Table to L, lay the Index upon the Line K L, turning the Table about, 'till through the Sight, you see your first Station at K, and there screw it fast, so that it alter not so long as your work continueth.

Then laying the Index to the point L, direct your Sights to the several marks as before, namely, to A C B F D E G, and from each of those marks draw Lines by the side of the Index; as A L, C L, B L, F L, D L, E L, and G L. So is your work finished at your second Station also.

Having thus done, first observe where the Line K A crosseth the Line L A, which is at A, at which point you may draw the Figure, or write the name of the thing which it representeth. *Secondly*, observe where the Line K B crosseth the Line L B, which is at B, at which point write the name of the place as before. *Thirdly*, observe where the Lines K C and L C intersect, which is at C, at which point also note the place. *Fourthly*, at the intersection of K D and L D, which is at D, write the name of the place as before. Do thus with all the rest of the places, be they never so many: So shall the several points of intersection, A B C D E F G, upon your Table, represent the respective places in the Town or City.

Now to know the Distance of any of these places one from another, you must take the Distance required in your Compasses, and apply it to the same Scale by which the Stationary distance K L was laid down, and it will there shew you the distance required.

And by this means may you make a true and accurate Map of any City, Town or Village, from two Towers, or like places, from whence all Churches, Towers, and other eminent Places may be seen, as the Bending of Rivers, Wind-mills, *&c.*

II. *By the* Theodolite.

Fig. I. AS in the laſt Chapter, make choice of two places, from either of which you may conveniently ſee all thoſe places you intend to deſcribe; which two places let be K and L. Then placing the Inſtrument at K, lay the Index on the Diameter thereof, and turn the whole Inſtrument about, 'till through the back Sights you eſpie your ſecond Station at L: Then fixing the Inſtrument there, direct your Sights to the ſeveral marks A B C D E F G, obſerving what degrees the Index cutteth when directed to any of the marks intended. As ſuppoſe, your Inſtrument being fixed at K, and the Sights directed to A, the Index cuts 83 deg. 50 minutes; at B, 97 deg. 55 minutes; at C, 114 deg. 10 minutes; at D, 123 deg. 40 minutes; at E, 134 deg. 35 minutes; at F, 138 degrees 30 minutes; and at G, 155 degrees 20 minutes.

Then removing your Inſtrument to L, lay the Index on the Diameter thereof, and turn it about 'till through the fore Sights you eſpie your former Station at K, as is before taught. Then directing the Sights to your firſt mark A, the Index cuts 33 degrees 50 minutes; at C, 43 degrees 40 minutes; at B, 54 degrees 10 minutes; at F, 64 degrees; at D, 73 degrees 20 minutes; at E, 87 degrees 15 minutes; and at G, 113 degrees 40 minutes.

Theſe ſeveral Obſervations of the degrees cut by the Index at both Stations ought to be noted in a Book or Paper, together with the Stationary Diſtance, as in this example.

		deg.	*min.*
First Station	A	83	50
	B	97	55
	C	114	10
	D	123	40
	E	134	35
	F	138	30
	G	155	20

The Stationary Diſtance 800 Foot.

Second Station	A	33	50
	C	43	40
	B	54	10
	F	64	00
	D	73	20
	E	87	15
	G	113	40

By the help of this Table of your Obſervations, you may at any time Protract the ſame upon Paper; and making a Scale of

equal Parts anſwerable to the Parts of your Stationary Diſtance, you may with your Compaſſes meaſure the Diſtance of any of theſe marks, or places one from another, or from either of your Stations.

III. *How to Protract the former Obſervations upon Paper, and to make a* Scale *to meaſure any of the* Diſtances.

Fig. I. YOur Paper or Parchment being provided, draw thereupon a Line at length, and therein aſſign two Points, as K and L, repreſenting your two Stations: Then upon your firſt Station at K, lay the Center of your *Protractor*, with the Meridian Line thereof (which is noted with E F) directly upon the line K L. Then lay the Table of your Obſervations before you; and ſeeing that at your firſt Obſervation the Index cut 83 degrees 50 minutes, you muſt therefore with your Protracting-pin make a mark againſt 83 degrees 50 minutes of your *Protractor*. Again, ſeeing that at your ſecond Obſervation the Index cut 97 degrees 55 minutes, therefore with your Protracting-pin make a mark upon your Paper againſt 97 degrees 55 minutes of your *Protractor*. And thirdly, ſeeing that at your third Obſervation your Index cut 114 degrees 10 minutes, you muſt likewiſe make a mark againſt 114 degrees 10 minutes. And thus muſt you do with all the reſt of your Obſervations, be they never ſo many: Which being done, from the Point or Station K, you muſt draw the ſtraight lines K A, K B, K C, K D, *&c.*

Then remove your *Protractor* to L, which ſignifies your ſecond Station, laying the Meridian Line thereof upon the Line K L; and then by your Table note the Angles of your Obſervations made at your ſecond Station, in all reſpects as you did thoſe of your firſt Station. So ſhall you find that at the firſt Obſervation at your ſecond Station, the Index cut 33 degrees 50 minutes; therefore with your Protracting-pin make a mark upon the Paper againſt 33 degrees 50 minutes of the *Protractor*. Again, the degrees cut at your ſecond Obſervation were 43 degrees 40 minutes; therefore make a mark againſt 43 degrees 40 minutes of your *Protractor*. Alſo the degrees cut at your third Obſervation were 54 degrees 10 minutes, againſt which likewiſe make a mark; dealing with all the reſt of your Obſervations in the ſame manner. Then through theſe ſeveral Points, from your Station L, draw ſtraight Lines 'till they interſect thoſe Lines before drawn from K, which will be the Points A B C D E F and G; which Points bear a juſt Proportion to the marks which you obſerved.

Now to find the Diſtance of any of theſe marks one from another, you muſt divide a Line into ſuch equal Parts, that your Stationary Diſtance K L may contain 800 of them. Your Scale being

ing thus made, take in your Compaſſes the Diſtance between any two Marks or Places here deſcribed, and apply it to your Scale; ſo ſhall it exactly ſhew you the true Diſtance between the two places ſo taken, in the ſame parts as the line K L was divided.

In this manner may you with ſpeed and exactneſs attain the true Diſtance and Situation of any Mark or Marks far remote, without approaching near any of them: And thus in over-grown Land, where you can neither go about it, nor meaſure within it, this Chapter will be of excellent uſe: "Such are the greateſt part of thoſe "vaſt Woods in *Carolina*, this Year ſold to the *Quakers*.

"For, if two Scaffolds be erected at a ſufficient Diſtance from "one another, higher than the tops of the Trees, and in ſuch places "that we can plot their Diſtance, as hereafter taught: Then let "Pikes with Flags be erected at the moſt remarkable bounds of the "Land then to be Plotted, and let Signals by Waving, and Colours "diſtinguiſh them from one another, at the two different Stations. "I ſay, having thus prepared things, a Surveyor may Survey and "Plott ten thouſand Acres of Land in one Day. And after he hath "Plotted theſe Obſervations, he may uſe any two of theſe to raiſe "his Scaffolds at, and ſo proceed through the whole Country. Of "this ſee more in the Appendix.

¶ I might here inſert divers other Caſes concerning the taking of Heights and Diſtances; as, divers Places lying in the ſame right Line, to find their Diſtances; or, part of a Diſtance or Altitude being given, to find the whole, with infinite others of that nature: But ſeeing that theſe are but Parts or Branches of what is here already delivered, and are rather Problems of Curioſity then Uſe, I will therefore paſs them over, and the rather, becauſe theſe being rightly underſtood, the performance of any other will be very eaſie. But remember always, in taking of inacceſſible Heights and Diſtances, as alſo in the Plotting of unpaſſable Grounds, that you take always your Stationary diſtance as large as may be. And if at any time you be required to take the Altitude of a Caſtle, Church or Tree, ſtanding on a Hill, you muſt perform it at two Operations: *Firſt*, by taking the Altitude of the Caſtle and Hill together, as one Altitude; and *Secondly*, by taking the Height of the Hill alone: And then ſubſtracting the Height of the Hill from the whole Height, the Remainder ſhall be the Height of the Caſtle. And here note alſo, that in the taking of all manner of Altitudes, whether Acceſſible or Inacceſſible, you muſt always add to the Height found, the Height of your Inſtrument from the Ground.

CHAP.

CHAP. XIV.

How to take the true Plot of a Field at one Station taken within the ſame Field, from whence you may ſee all the Angles: By the Plain Table, Theodolite *and* Circumferentor.

I. *By the* Plain Table.

Fig. II. HAving entred upon any Field to Survey thus, your firſt work muſt be to ſet up ſome viſible Mark at each Angle thereof, [*not near but in the very Angle*;] or let one go continually before you to every Angle, holding up a white Cloath, or the like, to direct you: Which being done, make choice of ſome convenient place about the middle of the Field, from whence you may behold all your Marks, and there place your Table, cover'd with a ſheet of Paper, the Needle hanging directly over the Meridian-line of the Card; (which you muſt always have regard unto, eſpecially when you are to Survey many Fields together.) Then make a Mark about the middle of your Paper, which ſhall repreſent that part of the Field where your Table ſtandeth; and laying the Index upon this Point, direct your Sights to the ſeveral Angles where you before placed your Marks, and draw Lines by the ſide of the Index upon the Paper: Then meaſure the Diſtance of every of theſe marks from your Table, and by your Scale ſet the ſame Diſtances upon the Lines drawn upon the Table, making ſmall Marks with your Protracting-pin, or Compaſs-point, at the end of every of them: Then with Lines being drawn from one to another of theſe Points, you ſhall have upon your Table the exact Plot of your Field; all the Lines and Angles upon the Table being proportional to thoſe of the Field.

Suppoſe you were to take the Plot of the Field A B C D E F. Having placed Marks in the ſeveral Angles thereof, make choice of ſome convenient place about the middle of the Field, as at L, from whence you may behold all the Marks before placed in the ſeveral Angles, and there place your Table: Then turn your Inſtrument about, 'till the Needle hang over the Meridian-line of the Card, the North-end of which Line is noted with a Flower-de-luce, and is repreſented in this Figure by the line N S.

Your Table being thus placed, with a ſheet of Paper thereupon, make a Mark about the middle of your Table which ſhall repreſent that place in the Field where your Table ſtandeth: Then, applying your Index to this Point, direct the Sights to the firſt mark at A, and the Index reſting there, draw a Line by the ſide thereof to the Point L: Then with your Chain meaſure the diſtance from L,

the

the place where your Table ſtandeth to A, your firſt Mark, which ſuppoſe to be 8 Chains 10 Links: Then take 8 Chains 10 Links from any Scale, and ſet that Diſtance upon the Line upon your Table from L to A, and at A make a Mark.

Then directing the Sights to B, the ſecond Mark, draw a Line by the ſide of your Index as before, and meaſure the Diſtance from your Table at L, to your mark at B, which ſuppoſe 8 Chains 75 Links: This Diſtance muſt be taken from your Scale, and ſet upon your Table from L to B, and at B make another Mark.

Then directing the Sights to the third mark C, and draw a Line by the ſide of the Index, meaſuring the Diſtance from L to C, which ſuppoſe 10 Chains 65 Links: This Diſtance being taken from your Scale, and applied to your Table from L to C, ſhall give you the point C, repreſenting your third Mark.

In this manner you muſt deal with the reſt of the marks at D, E and F, and more, if the Field had conſiſted of more Sides and Angles.

Laſtly, when you have made Obſervation of all the Marks round the Field, and found the Points A B C D E and F upon your Table, you muſt draw Lines from one Point to another, 'till you conclude where you firſt began. As, draw a Line from A to B, from B to C, from C to D, from D to E, from E to F, and from F to A, where you began; then will A B C D E F be the exact Figure of your Field, the ſides and Angles of the ſaid Figure bearing an exact Proportion to thoſe in the Field: And the line N S, in this and the following Figures, always repreſenteth the Meridian-line.

II. *By the* Theodolite.

Fig. II. PLace Marks at the ſeveral Angles of the Field as before, and make choice of ſome convenient place about the middle thereof, as L, from whence you may ſee all the Marks, and there place your Inſtrument, the Needle hanging directly over the Meridian-line in the Card.

This done, direct your Sights to the firſt mark at A, noting what degrees the Index cutteth, which let be 36 degrees 45 minutes: Theſe 36 degrees 45 minutes muſt be noted down in your Field-book in the firſt and ſecond Columns thereof. Then meaſure the diſtance from L, the place of your Inſtrument to A, your firſt mark, which let contain 8 Chains 10 Links. Theſe 8 Chains 10 Links muſt be placed in the third and fourth Columns of your Field-book, as hath been directed in the Deſcription thereof, and as is done in this Chapter.

Then direct the Sights to B, your ſecond Mark, and note the degrees cut by the Index, which let be 99 degrees 15 minutes, and the diſtance L B 8 Chains 75 Links. The 99 degrees 15 minutes muſt be noted in the firſt and ſecond Columns of your Field-book, and the 8 Chains 75 Links in the third and fourth Columns.

Then direct your Sights to C, your third Mark, and note the degrees cut by the Index, which let be 163 degrees 15 minutes, and let the Distance L C be 10 Chains 65 Links. The 163 degrees 15 minutes must be noted in the first and second Columns of your Field-book, and the 10 Chains 65 Links in the third and fourth Columns thereof.

Then direct your Sights to D, your fourth Mark, and note the degrees cut by the Index, which let be 212 degrees:——

(¶ And here you must note, That in using the degrees on the Frame of the Table, after the Index hath passed 180 degrees, which is at the line N S, (representing always the Meridian-line) you must then count the degrees backward, according as they are numbred on the Frame of the Table, from 190 to 360.)

——then measure the Distance L D, which let be 8 Chains 53 Links. The 212 degrees must be noted in the first Column of your Field-book, and the 8 Chains 53 Links in the third and fourth Columns thereof.

Then direct your Sights to E, the Index cutting 287 degrees 15 minutes, and the Distance L E being 8 Chains 15 Links. These must be noted in your Field-book as before; the 287 degrees 15 minutes in the first and second Columns, and the 8 Chains 15 Links in the third and fourth.

Lastly, Direct the Sights to F, your last Mark, the Index cutting 342 degrees, and the Distance L F being 9 Chains 55 Links. These must be noted down in your Field-book in all respects as the former, *viz.* the 342 degrees in the first Column, and the 6 Chains 55 Links in the third and fourth. Then will your Observations noted in your Field-book stand as in this Table following.

	Degrees	*Minutes*	*Chains*	*Links.*
A	36	45	8	10
B	99	15	8	75
C	163	15	10	65
D	212	00	8	53
E	287	15	8	15
F	342	00	9	55

III. *By the* Circumferentor.

Fig. II. THere is little difference between the work of this and the last Chapter. For the Marks being placed in the several Angels of the Field, and the Station appointed at L, place there the Instrument, and turning it about, direct the Sights to A, (the Flower-

Flower-de-luce of the Card being always towards you, the South-end of the Needle cutting 36 degrees 45 minutes, the ſame which the Index of the *Theodolite* did in the laſt Chapter; Then meaſuring the Diſtance from L to A, you will find it to contain, as before, 8 Chains 10 Links; which you muſt note down in your Field-book, as in the laſt Chapter.

Then turning the whole Inſtrument about (as before) direct the Sights to B, the South-end of the Needle cutting 99 degrees 15 minutes, and the diſtance L B will contain 8 Chains 75 Links; which note down in your Book alſo.

In this manner muſt you direct the Sights to all the other Angles C D E and F, and you ſhall find the South-end of the Needle always to cut the ſame degrees in the Card, as the Index of the *Theodolite* did, and the meaſured Lines L C, L D, L E, and L F, will be likewiſe the ſame: So that the Table of Obſervations in the laſt Chapter will ſerve to Protract either this or the other work, as is taught in the next Chapter.

IV. *How to Protract any Obſervation taken according to the former Directions.*

Fig. II. FIrſt, draw upon your Paper or Parchment a Line at length, which ſhall repreſent the Meridian-line N S in the Figure: Then make choice of ſome Point or other in that Line, which ſhall repreſent your Station or Place of ſtanding in the Field, as L: Upon this Point place the Center of your *Protractor*, ſo that the Meridian-line E F of the *Protractor*, may lie directly upon the Meridian-line N S of this Figure.

Then laying your Field Book before you, and ſeeing that at your firſt Obſervation at A, the Index of the *Theodolite*, or the Needle of the *Circumferentor*, cut 36 degrees 45 minutes, you muſt therefore againſt 36 degrees 45 minutes of your *Protractor* make a mark upon your Paper.

2. Seeing the degrees cut at your ſecond Obſervation were 99 degrees 15 minutes, you muſt againſt 99 degrees 15 minutes of your *Protractor* make a Mark upon your Paper.

3. The degrees cut at your third Obſervation were 165 degrees 15 minutes, therefore againſt 165 degrees 15 minutes make a Mark upon your Paper.

4. The degrees cut by the Index or Needle at your fourth Obſervation being 212 degrees.——

(¶ Now becauſe 212 degrees is greater then 180 degrees, you muſt therefore turn the Semicircle of the *Protractor* downwards; yet the Line E F thereof muſt lie directly upon the Meridian-line N S as before: And ſo you muſt always do when the Angle you are to Protract exceedeth 180 degrees.)

——you

——you muſt againſt 212 degrees of the *Protractor* make a Mark upon your Paper.

5. Seeing the degrees cut at your fifth Obſervation were 287 degrees 15 minutes, therefore make a Mark againſt 287 degrees 15 minutes of the *Protractor*.

Laſtly, the degrees cut at your laſt Obſervation were 342, therefore againſt 342 degrees of your *Protractor* make a Mark with your Protracting-pin, as before.

Having thus Protracted all the degrees of your ſeveral Obſervations, take away your *Protractor*, and laying a Rular to the point L, draw obſcure Lines from L through thoſe Points; which Lines will be L A, L B, L C, L D, L E, and L F.

This done, you muſt obſerve by your Field-book the length of every Line.

As the line L A at your firſt Obſervation being 8 Chains 10 Links, therefore 8 Chains 10 Links being taken from your Scale, and ſet upon your Paper from L to A, it ſhall give you the point A upon your Paper.

2. The length of your ſecond Line being 8 Chains 75 Links, you muſt take 8 Chains 75 Links from your Scale, and ſet them upon your Paper from L to B.

3 The line L C being 10 Chains 65 Links, you muſt therefore take 10 Chains 65 Links from your Scale, and ſet them upon your Paper from L to C.

And thus muſt you deal with all the reſt of the Lines, as L D, L E, and L F.

Laſtly, draw the lines A B, B C, C D, D E, E F, and F A, ſo ſhall you have the exact Figure of the Field upon your Paper.

¶ In theſe four laſt Chapters you are taught how to take the Plot of any Field at one Station taken in the midſt thereof, both by the *Plain Table*, *Theodolite* and *Circumferentor*, and alſo how to Protract the ſame. This way of Plotting of a Field is ſeldom or never uſed in Surveying of divers Parcels, but for one particular Field whoſe ſides are ſtraight it is as good as any, but cannot always be uſed; ſometimes for ſpoiling of Graſs or Corn upon the Ground, ſometimes for Water, or when the ſides are crooked, and other the like Impediments. But divers other Varieties will appear in the following Chapters.

CHAP.

CHAP. XV.

How to take the Plot *of a* Field *at one* Station *taken in any* Angle *thereof, from whence all the other* Angles *may be ſeen, by the* Plain Table, Theodolite *and* Circumferentor.

I. *By the* Plain Table.

Fig. 3. PLace your Table in ſome convenient Angle [*in the Angle not near it*] in the Field to be meaſured, and turn it about, 'till the Needle hang directly over the Meridian-line in the Card, and there fix it: Then draw a Line parallel to the ſide of your Table, as N S; in which Line aſſign any Point at pleaſure, as H, which ſhall repreſent your Station or Place of ſtanding: Unto this Point apply the Index, and direct the Sights to A, and draw a Line upon your Paper, as H A, and meaſure the diſtance H A, (as was directed before in *Chap.* 14.) Then direct the Sights to B, your ſecond Mark, and there likewiſe draw a Line H B, meaſuring the diſtance H B, as was taught in the fore-mentioned Chapter.

In like manner direct the Sights to C D E F and G, drawing lines by the ſide of your Index at every Obſervation, and meaſure with your Chain the Diſtance from H (the place where your Inſtrument ſtandeth) to the ſeveral Angles of the Field, A, B, C, D, E, F and G: Which diſtances being taken in your Compaſſes, from any Scale, ſet them upon your Table from H, upon the ſeveral lines H A, H B, H C, H D, H E, H F and H G; ſo ſhall you have upon your Table the Points A, B, C, D, E, F and G: By which Marks draw the lines H A, A B, B C, C D, D E, E F, F G and G H; which lines will include the exact Figure of the Field upon your Table.

¶ This way of Meaſuring is alſo liable to the inconvenience of that in the laſt Chapter, and therefore but in ſome caſes to be uſed.

II. *By the* Theodolite.

Fig. 3. IN the ſame Figure, having placed your Inſtrument at H, (as is taught in the fore-going Chapter) direct the Sights to A, your firſt Mark, noting the degrees cut by the Index, which ſuppoſe 22 degrees 15 minutes: Theſe degrees and minutes muſt be noted in the firſt and ſecond Columns of your Field-book, (as hath been before ſufficiently taught.) Then with your Chain meaſure the diſtance from your Station at H to the angle A, which let be 8 Chains 46 Links, which you muſt place in the third and fourth

Columns of your Field-book, according to the former Directions.

2. Direct your Sights to B, noting the degrees there cut, which ſuppoſe 42 degrees 45 minutes: Theſe degrees and minutes place in the firſt and ſecond Columns of your Field-book, and meaſure the diſtance H B, 15 Chains 21 Links, and note them down in the third and fourth Columns thereof.

3. Direct your Sights to C, the degrees cut being 66 degrees 30 minutes, and the diſtance H C, 16 Chains 64 Links: Note theſe alſo in your Field-book, as before.

And in this manner muſt you deal with the other Marks D, E, F, and G: So having noted them all in your Field-book, they will ſtand as followeth.

	Degrees.	*Minutes.*	*Chains.*	*Links.*
A	22	15	8	46
B	42	45	15	21
C	66	30	16	64
D	86	45	16	23
E	122	30	16	68
F	130	15	5	22
G	162	00	7	73

III. *By the* Circumferentor.

Fig. 3. PLace your Inſtrument at H, and direct the Sights to A, (obſerving the Cautions formerly delivered in the Uſe of this Inſtrument) the Needle cutting 22 degrees 15 minutes, and the diſtance H A containing 8 Chains 46 Links; which agrees exactly with the firſt Obſervation in the laſt Chapter. Theſe degrees and minutes, together with the meaſur'd diſtance H A, muſt be noted down in the ſeveral Columns of your Field-book. And if you make Obſervations round about the Field, from Angle to Angle, and meaſure the length of every line from H, to B, C, D, E, F and G, you ſhall find the degrees cut by the Needle to be the ſame with thoſe (in the laſt Chapter) cut by the Index, and the meaſured Diſtances to be likewiſe equal: And if you make a Table of your Obſervations, you ſhall find it the ſame with that in the laſt Chapter.

IV. *How to Protract any Obſervation taken, according to the foregoing Doctrine.*

Fig. 3. FIrſt, draw the Meridian-line N S, and make choice of a Point therein repreſenting your Stationary Angle, as at H, to which Point apply the Center of your *Protractor*, the Semicircle upwards. Then laying your Field-book before you, you may perceive

perceive that at your firſt Obſervation (which was at A) the Index of the *Theodolite*, or the Needle of the *Circumferentor*, cut 22 degrees 15 minutes; therefore make a Mark againſt 22 degrees 15 minutes, and draw the line H A.

2. The degrees cut at your ſecond Obſervation, at B, being 42 degrees 45 minutes, make a Mark likewiſe againſt 42 degrees 45 minutes of your *Protractor*, and draw the line H B.

3. The degrees cut at your third Obſervation being 66 degrees 30 minutes, make a Mark againſt 66 degrees 30 minutes, and draw the line H C.

And in this manner muſt you proceed with the reſt of your Obſervations, D, E, F and G.

Having thus Protracted your angular Obſervations, proceed now to your Lineal; namely, to the length of your Lines, noted in the third and fourth Columns of your Field-book.

1. Seeing that the length of your firſt line, H A, was 8 Chains 46 Links, you muſt take 8 Chains 46 Links from your Scale, and apply it to your Paper from H unto A.

2. The length of your ſecond line, H B, being 15 Chains 21 Links, take 15 Chains 21 Links from your Scale, and apply that diſtance to your Paper from H unto B.

3. The diſtance of your third Mark, H C, being 16 Chains 64 Links, take the diſtance from your Scale, and apply it to your Paper from the Point H unto C.

In all reſpects as before, you muſt proceed with the meaſuring of all the other Lines about the Field, were they never ſo many.

Laſtly, if from theſe Points, A B C D F F G and H, you draw the Lines A B, B C, C D, D E, E F, F G and G H, you ſhall have upon your Paper the exact Figure of your Field.

¶ And herein you may receive abundant ſatisfaction, to ſee your ſeveral Inſtrumental Operations, and your Geometrical Protraction ſo exactly to agree. And if at any time you make ſeveral Obſervations of any one piece of Ground, according to the directions of the foregoing Chapter, or the like; if you find them not exactly to agree, you may be ſure you have failed in one or other of your Obſervations, and therefore, before you proceed farther, it is beſt to reform your firſt Error.

CHAP.

CHAP. XVI.

How to take the Plot of a Field at two (or more) Stations taken in any parts thereof, by meaſuring from either of the Stations to the viſible Angles: By *the* Plain Table, Theodolite *and* Circumferentor.

I. *By the* Plain Table.

Fig. 4. THIS manner of work is chiefly to be uſed in ſuch Fields which are ſo irregular, that from any one part thereof you cannot diſcern all the Angles; or elſe in ſuch whoſe largeneſs will not permit a ſufficient view of all the Angles at once. The manner of work will be the very ſame with that in the *Chap.* 14. only the Inſtrument, in this, muſt be placed in two or three ſeveral places; whereas, in that, the ſame thing was effected at once placing of the Inſtrument.

Suppoſe then that ABCDEFGHIKL and M were ſuch an irregular Field as is before ſpoken of. Having made choice of two places within the ſame for your two Stations, as O and Q, from which you may conveniently ſee all the Angles.

Firſt, place your Table at O, turning it about, 'till the Needle hang directly over the Meridian-line in the Card, repreſenting in this Figure by the line NOS. Then fixing the Table there, you muſt

(1) direct the Sights to A, and by the ſide of the Index draw the Line AO, containing 7 Chains 46 Links:
(2) direct the Sights to B, and draw the Line OB, containing 7 Chains 18 Links:
(3) direct the Sights to C, and draw the Line OC, containing 7 Chains 21 Links:
(4) direct the Sights to D, and draw the Line OD, containing 6 Chains 33 Links:
(5) direct the Sights to E, and draw the Line OE, containing 5 Chains 57 Links:
(6) direct the Sights to K, and draw the Line OK, containing 7 Chains 83 Links:
(7) direct the Sights to L, and draw the Line OL, containing 9 Chains 95 Links:
(8) direct the Sights to M, and draw the Line OM, containing 5 Chains 08 Links.

Having thus made Obſervation of theſe Angles, which are all that can conveniently be ſeen from your firſt Station at O, and drawn the ſeveral Lines, OA, OB, OC, OD, OE, OK, OL, and OM; and upon them ſet the ſeveral lengths as you found them by meaſuring

ſuring, as from O to A, 7 Chains 46 Links; from O to B, 7 Chains 18 Links, *&c.* you muſt then lay the Index again to the point O, and direct the Sights to your ſecond Station at Q, drawing the line OQ: Then meaſure the Diſtance from O to Q, which let contain 8 Chains 89 Links.

Then remove your Inſtrument to Q, and lay the Index upon the line OQ, turning the Table about, 'till through the Sights you eſpie your firſt Station at O; then will the Needle hang directly over the Meridian-line in the Card as before; and your Inſtrument is truly ſituated in the ſame Poſition as before; ſo that you may now deal with the Angles F, G, H, and I, (which before you could not conveniently ſee) as you did with thoſe on the other ſide of the Field, by laying the Index to the point Q, and directing the Sights.

(1) to E, and drawing the Line Q E, containing 5 Chains 10 Links:
(2) to F, and drawing the Line Q F, containing 7 Chains 64 Links:
(3) to G, and drawing the Line Q G, containing 6 Chains 40 Links:
(4 to H, and drawing the Line Q H, containing 5 Chains 33 Links:
(5) to I, and drawing the Line Q I, containing 6 Chains 95 Links:
(6) to K, and drawing the Line Q K, containing 7 Chains 61 Links:

Theſe Angles being Obſerved, and the lines meaſured as the former were, you ſhall find the ſeveral points, E, F, G, H, I, and K, on this ſide of the Field alſo: So that you may draw the lines A B, B C, C D, D E, E F, F G, G H, H I, I K, K L, L M, and M A; which ſhall repreſent upon your Table the exact Figure of the Field to be meaſured.

¶ And here Note, That in this Example I make Obſervation of the Angles E and K at both Stations: But there was no need thereof, only this ſatisfaction will accrue thereby; that when you have meaſured your Stationary diſtance O Q, and removed your Inſtrument to Q, and there fixed it; when you direct the Sights to E or K, and meaſure the diſtance Q E, Q K, and ſet it off from Q, you ſhall find the points E and K to fall directly upon the ſame points E and K formerly drawn, if there be no Errour in your Work.

And in this manner may you make three, four or five Stations for one Field, if need require: Or, if two or three ſmall Cloſes ſhould lie together, by this means they may be Plotted upon one ſheet of Paper by this Artifice; and ſo in this Figure IV. you may imagine the part A, B, C, D, E, K, L, M, to be one Field; and E, F, G, H, I, K, to be another.

II. *By the* Theodolite.

Fig. IV. YOur Station O and Q being choſen, place your Inſtrument in the Field at O, and turn it about, 'till the Needle hang over the Meridian-line; and there fixing it, direct the

Sights to A, the Index cutting 19 degrees 10 minutes, and the line OA containing 7 Chains 46 Links. The 19 degrees 10 minutes muſt be placed in the firſt and ſecond Columns of your Field-book; and the 7 Chains 46 Links in the third and fourth Columns thereof.

Then direct the Sights to B, the Index cutting 53 degrees 30 minutes, and the line OB containing 7 Chains 18 Links; which note down in your Field-book, as before.

In this manner proceed with the reſt of the lines and angles, namely, ſo many as you intend to obſerve at your firſt Station, *viz.* A, B, C, D, K, L and M: Which done, direct the Sights to your ſecond Station at Q, the Index cutting 18 degrees 15 minutes; which note down in your Field-book by it ſelf. Alſo meaſure the Stationary diſtance OQ, 8 Chains 89 Links, as before. This alſo muſt be noted in your Field-book.

Having thus finiſhed one part of the Field, remove your Inſtrument to Q, and laying the Index upon 18 degrees 15 minutes, turn it about, 'till through the Sights you eſpie your firſt Station at O; then will the Needle hang over the Meridian-line, and the Inſtrument will be truly ſituate.

Then direct the Sights to E, the Index cutting 52 degrees 15 minutes, and the line QE containing 5 Chains 10 Links; which muſt be noted in your Field-book in all reſpects as formerly. In this manner make Obſervation of all the other lines and angles; as E, F, G, H, I and K, which being collected into your Field-book, will ſtand as followeth.

	Deg.	*Min.*	*Chai.*	*Link.*	
A	19	10	7	46	The Firſt Station at O.
B	53	30	7	18	
C	95	15	7	21	
D	132	00	6	33	
E	166	30	5	57	
K	251	30	7	83	
L	282	00	9	95	
M	304	30	8	05	

The Stationary Diſtance OQ is 8 Chains 89 Links; and the Angle OQN, 18 degrees 15 minutes, the inclination or difference of Meridians.

E	52	15	5	10	The Second Station at Q.
F	99	30	7	64	
G	148	30	6	40	
H	232	30	5	33	
I	275	00	6	95	
K	321	30	7	61	

III. *By*

III. *By the* Circumferentor.

Fig. IV. THE Use of this Instrument in taking the Plot of a Field, by observing the lines and angles in the midst thereof, is sufficiently shewn already in *Chap.* 16. And the work of this Chapter differeth nothing therefrom, only in this you make Observation in two places. Therefore placing the Instrument at O, and directing the Sights to A, B, C, D, E, K, L and M, you shall find the degrees cut by the Needle to be the same with those collected in your Field-book at your first Station at O, taken with the *Theodolite*. Also, your Instrument being removed to Q, and Observation made of the several Angles there, namely, of the Angles E, F, G, H, I and K, they will likewise be found the same with those observed by the *Theodolite* at your second Station in the last Chapter. And therefore to make repetition thereof again in this place, were superfluous.

¶ Here Note, That the *Plain Table* and *Theodolite* are the most convenient Instruments for these kind of Practices hitherto treated of, and not the *Circumferentor*: I only have hinted the Use thereof, that the agreement of the several Instruments might be taken notice of; the *Circumferentor* serving chiefly for large Champain Plains, Wood-Lands, Sea-Coasts, Harbours, *&c.*

IV. *How to Protract any Observations taken according to the directions of this Chapter.*

Fig. IV. DRaw upon your Paper the Meridian-line N O S, the Point O representing your first Station: Upon this Point O place the Center of your *Protractor*, laying the line E F thereof directly upon the Meridian-line N S: Then laying your Field-book before you, observe the degrees there noted, namely,

(1) at A, 19 degrees 10 minutes, the Line O A containing 7 Chains 46 Links;
(2) at B, 53 degrees 30 minutes, the Line O B containing 7 Chains 18 Links;
(3) at C, 95 degrees 15 minutes, the Line O C containing 7 Chains 21 Links;

and so of the rest: Against which degrees and minutes make marks by the edge of your *Protractor*; and draw Lines from O through those marks, as O A, O B, O C, O D, O E, O K, O L, O M; and upon those lines set off the several lengths from O, as you find them collected in your Field-book.

Having

Having thus Protracted the Obſervation of your firſt Station, (before you move your *Protractor*) make a Mark againſt 18 degrees 15 minutes, and draw the line O Q, ſetting off 8 Chains 89 Links, the length thereof, being the Stationary Diſtance from O to Q: Then upon the point Q, place the Center of the *Protractor*, as before, moving it up and down, 'till the line O Q lies juſt under 18 degrees 15 minutes; and holding it there, lay your Field-book before you, and prick down by the ſide thereof the ſeveral degrees and minutes, as by your Inſtrument you obſerved them, together with the lengths of the lines as they were meaſured, drawing lines through thoſe Points alſo, as the lines Q E, Q F, Q G, Q H, Q I and Q K.

Laſtly, draw the Lines A B, B C, C D, D E, E F, *&c.* So ſhall you have upon your Paper the exact Plot of your Field; in which (if there be no Errour in your Work) the line M A being drawn, will cloſe exactly with the line B A in the Point A.

CHAP. XVII.

How to take the Plot of a Field at two Stations taken about the middle thereof, from either of which all the Angles in the Field may be ſeen, by meaſuring of one Line only.

I. *By the* Plain Table.

Fig. V. NEceſſity may ſometimes require the Plotting of a Field according to the directions which I ſhall deliver in this Chapter; yet I would have as little uſe made thereof as poſſibly can be, in regard of the acuteneſs of the Angles, or rather, of the oblique Interſections, which (in ſome places) the lines at either Station will make one with another: Which is more liable to Errour then any of the ways formerly taught, although it be grounded upon as firm a Geometrical Principle as any of them.

Let A B C D E F G H be the Figure of a Field, and let the two Stations taken within the ſame be O and Q.

Having placed your Inſtrument at O, your firſt Station, the Needle hanging directly over the Meridian-line of the Card, you muſt,

(1) direct the Sights to A, and draw the Line O A;
(2) direct the Sights to B, and draw the Line O B;
(3) direct the Sights to C, and draw the Line O C;
(4) direct the Sights to D, and draw the Line O D;
(5) direct the Sights to E, and draw the Line O E;
(6) direct the Sights to F, and draw the Line O F;
(7) direct the Sights to G, and draw the Line O G;
(8) direct the Sights to H, and draw the Line O H.

This

This done, direct the Sights to your ſecond Station at Q, and draw the line O Q upon your Table: Then (with your Chain) meaſure out your Stationary Diſtance O Q, which is 7 Chains, *and lay it from* O *to* Q; and removing your Inſtrument to Q, lay the Index upon the line O Q; and looking through the Sights, turn the Table about, 'till you ſee a Mark ſet up at your former Station at O, and there fix the Table: And when you have ſo fixed it, (if you have truly taken your Back-ſight, the Needle will hang directly over the Meridian-line of the Card as before) make Obſervation at Q, as you did before at O. As,

(1) direct the Sights to A, and draw the Line Q A;
(2) direct the Sights to B, and draw the Line Q B;
(3) direct the Sights to C, and draw the Line Q C;
(4) direct the Sights to D, and draw the Line Q D;
(5) direct the Sights to E, and draw the Line Q E;
(6) direct the Sights to F, and draw the Line Q F;
(7) direct the Sights to G, and draw the Line Q G;
(8) direct the Sights to H, and draw the Line Q H.

Now you may plainly perceive by the Figure, where the correſpondent Lines at each Station interſect or croſs each other. As,

(1) the Lines O A and Q A interſect each other at A:
(2) the Lines O B and Q B interſect each other at B:
(3) the Lines O C and Q C interſect each other at C:
(4) the Lines O D and Q D interſect each other at D:
(5) the Lines O E and Q E interſect each other at E:
(6) the Lines O F and Q F interſect each other at F:
(7) the Lines O G and Q G interſect each other at G:
(8) the Lines O H and Q H interſect each other at H:

Therefore, if from one to another of theſe Points ſucceſſively you draw Lines, you ſhall have upon your Paper the exact Symmetry or Proportion of your Field; as namely, the lines A B, B C, C D, D E, *&c.*

In this kind of Plotting you cannot but perceive a wonderful quick diſpatch, you being to meaſure nothing but the Diſtance between your Stations: But by reaſon of the acuteneſs of the Angles (without exact and curious drawing of your Lines, and obſerving well the preciſe Points of Interſection) you may run into groſs abſurdities and miſtakes.

II. *By the* Theodolite *or* Circumferentor.

Fig. V. YOU may perceive by what hath been ſaid in the foregoing Chapter, that the manner of work is the ſame both with the *Theodolite* and *Circumferentor*; and therefore in this place I make but one Example for both Inſtruments.

Now to take the Plot of the Field A B C D E F G and H by either of theſe Inſtruments, place your Inſtrument at O, your firſt Station, and turn it about, 'till the Needle hang over the Meridian-line N S, and fixing it there,

(1) direct the Sights to A, the Index or Needle cutting 21 degrees 30 minutes:
(2) direct the Sights to B, the Index or Needle cutting 69 degrees 15 minutes:
(3) direct the Sights to C, the Index or Needle cutting 124 degrees 45 minutes:
(4) direct the Sights to D, the Index or Needle cutting 168 degrees 10 minutes:
(5) direct the Sights to E, the Index or Needle cutting 202 degrees 30 minutes:
(6) direct the Sights to F, the Index or Needle cutting 237 degrees 30 minutes:
(7) direct the Sights to G, the Index or Needle cutting 307 degrees 00 minutes:
(8) direct the Sights to H, the Index or Needle cutting 328 degrees 30 minutes.

This done, meaſure your Stationary Diſtance O Q, which ſuppoſe to contain 7 Chains; and remove your Inſtrument to Q, turning it about, 'till the Needle hang directly over the Meridian line, as before, and there fix it. Then,

(1) direct the Sights to A, the Index or Needle cutting 11 degrees 00 minutes:
(2) direct the Sights to B, the Index or Needle cutting 35 degrees 30 minutes:
(3) direct the Sights to C, the Index or Needle cutting 79 degrees 45 minutes:
(4) direct the Sights to D, the Index or Needle cutting 153 degrees 15 minutes:
(5) direct the Sights to E, the Index or Needle cutting 224 degrees 30 minutes:
(6) direct the Sights to F, the Index or Needle cutting 279 degrees 30 minutes:
(7) direct the Sights to G, the Index or Needle cutting 329 degrees 00 minutes:

(8) direct

(8) direct the Sights to H, the Index or Needle cutting 347 degrees 30 minutes:

Having thus made Obſervation of all the Angles round about the Field at both Stations, and noted the Degrees cut by the Index of the *Theodolite*, or the Needle of the *Circumferentor*, and put them down in your Field-book, together with the Diſtance between your two Stations; you may proceed to Protract your Work as is taught in the next Chapter.

III. *How to Protract any Obſervations taken according to the foregoing Directions.*

Fig. V. FIrſt draw the Meridian-line N S; upon which line aſſign any Point at pleaſure, as O, for your firſt Station; unto which Point apply the Center of your *Protractor*, with the line E F thereof upon the Meridian-line N S. Then look into the Field-book for the degrees obſerved at your firſt Station at O, and make marks againſt thoſe degrees by the edge of your *Protractor*: And when you have marked them all, draw Lines from O through every of them, as the lines O A, O B, O C, *&c.*

Then from your Scale take 7 Chains, (which is your Stationary Diſtance) and place it from O to Q, which repreſents your ſecond Station. Upon this point Q place the Center of your *Protractor*, and laying your Field-book before you, prick down the degrees by the edge of the *Protractor*, as you find them noted in your Field-book at your ſecond Station at Q, and through thoſe Points draw the lines Q A, Q B, Q C, *&c.*

The Line Q A croſſing the Line O A in the Point A.
The Line Q B croſſing the Line O B in the Point B.
The Line Q C croſſing the Line O C in the Point C.
The Line Q D croſſing the Line O D in the Point D.
The Line Q E croſſing the Line O E in the Point E.
The Line Q F croſſing the Line O F in the Point F.
The Line Q G croſſing the Line O G in the Point G.
The Line Q H croſſing the Line O H in the Point H.

Therefore if you draw the lines A B, B C, C D, D E, E F, F G, G H and H A, it ſhall be the exact Plot or Figure of the Field required.

¶ I might now proceed to ſhew the manner of taking the Plot of any Field without approaching nigh the ſame: But in regard the performance thereof differeth nothing at all from that which is already taught in the 13, 14, and 15 Chapters of this Fourth Book, I ſhall therefore in this place paſs it over as ſuperfluous.

CHAP.

CHAP. XVIII.

How to take the Plot of a Wood, Park, or other large Champain Plain, by meaſuring round about the ſame, and making Obſervation at every Angle.

I. *By the* Plain Table.

Fig. VI. HItherto we have ſhewed how the Plot of any Plain and even ground, or any ſmall Encloſure, may be taken ſeveral ways, as being the eaſieſt for a Practitioner to try experience upon: I now come to ſhew how the Plot of any Champain Plain or over-grown Wood may be meaſured; for in ſuch kind of grounds the former directions will be of little validity, for the largeneſs of the Plain, or the thickneſs of the Wood, may many times hinder both your Sights and meaſuring: Therefore the beſt way to meaſure theſe kinds of Lands is, to go about them, and make Obſervation at every Angle.

Suppoſe the following Figure A B C D E F G to be a large Wood, or other Champain Plain, whoſe Plot you deſire to take upon your *Plain Table*.

1. Place your Inſtrument at the Angle A, directing your Sights to the next Angle at B, and by the ſide thereof draw a Line upon your Table, as the line A B: Then meaſure by the Hedge-ſide from the angle A, to the angle B, which ſuppoſe 12 Chains 5 Links: Then from your Scale take 12 Chains 5 Links, and ſet that Diſtance upon your Table from A to B: Then turn your Index about, and direct the Sights to G, the angle on the other ſide of A, and draw the line A G upon the Table: But at preſent you need not to meaſure the Diſtance.

2. Remove your Inſtrument from A, and ſet up a Mark where it laſt ſtood, and place your Inſtrument at the ſecond angle at B: Then laying the Index upon the line A B, turn the whole Inſtrument about, 'till through the Back-ſights you ſee the Mark which you ſet up at A, and there ſcrew the Inſtrument: Then laying the Index upon the Point B, direct your Sights to the third angle at C, and draw the line B C upon your Table: Then meaſuring the Diſtance B C 4 Chains 45 Links, take that Diſtance from your Scale, and ſet it upon your Table from B to C.

3. Remove your Inſtrument from B, and ſet up a Mark in the room thereof, and place your Inſtrument at C, laying the Index upon the line C B; and turn the whole Inſtrument about, 'till through the Back-ſights you eſpie your Mark ſet up at B, and there faſten the Inſtrument: Then laying the Index on the Point C, direct the

the Sights to D, and draw upon your Table the line C D: Then meaſure from C to D 8 Chains 85 Links, and ſet that Diſtance upon your Table from C to D.

4. Remove your Inſtrument to D, (placing a Mark at C where it laſt ſtood) and lay the Index upon the line D C, turning the whole Inſtrument about, 'till through the Back-ſights you eſpie the Mark at C, and there faſten the Inſtrument: Then lay the Index on the Point D, and direct the Sights to E, and draw the line D E: Then with your Chain meaſure the Diſtance D E 13 Chains 4 Links, and ſet that Diſtance upon your Table from the Point D unto E.

5. Remove your Inſtrument to E, (placing a Mark at D where it laſt ſtood) and laying the Index upon the line D E, turn the whole Inſtrument about, 'till through the Back-ſights you ſee your Mark at D, and there faſten the Inſtrument: Then lay the Index on the Point E, and direct the Sights to F, and draw the line E F: Then meaſure the Diſtance E F 7 Chains 70 Links, which take from your Scale, and ſet it on your Table from E to F.

6. Remove your Inſtrument to F, (placing a Mark at E where it laſt ſtood) and lay the Index upon the line E F, turning the Inſtrument about, 'till through the Back-ſights you ſee your Mark ſet up at E, and there faſten the Inſtrument: Then laying the Index on the Point F, direct the Sights to G, and draw the line F G upon your Table; which line F G will cut the line A G in the Point G: Then meaſure the Diſtance F G 5 Chains 67 Links, and ſet that off upon your Table from F to G.

7. Remove your Inſtrument to G, (ſetting up a Mark at F where it laſt ſtood) and lay the Index upon the line F G, turning the whole Inſtrument about, 'till through the Sights you ſee the Mark at F, and there faſten the Inſtrument: Then laying the Index upon the Point G, direct the Sights to A, (your firſt Mark) and draw the line G A, which (if you have truly wrought) will paſs directly through the Point A where you firſt began.

In this manner may you take the Plot of any Champain Plain, be it never ſo large. And here Note, That many times Hedges are of ſuch a thickneſs, that you cannot come near the ſides or Angles of the Field, either to place your Inſtrument, or meaſure your lines: Therefore in ſuch Caſes, you muſt place your Inſtrument, and meaſure your lines parallel to the ſide thereof, and then your work will be the ſame as if you meaſured the Hedge it ſelf.

Note alſo, That in thus going about a Field, you may much help your ſelf by the Needle: For look what degree of the Card the Needle cuts at one Station, if you remove your Inſtrument to the next Station, and with your Back-ſights look to the Mark where your Inſtrument laſt ſtood, you ſhall find the Needle to cut the ſame degree again, which will give you no ſmall ſatisfaction in the proſecution of your work. And though there be 100 ſides or more, your Needle will ſtill cut the ſame degree at all of them, except you have committed ſome former Errour; therefore at every Station have an Eye to your Needle as well as to your Back-ſight.

Of ſhifting of Paper.

In the taking of the Plot of a Field by the *Plain Table*, and going about the ſame, as is taught in this Chapter, it may ſo fall out (if the Field be very large, or that you are to take many Incloſures together) that the Sheet of Paper upon your Table will not hold all your Work, but you muſt be forced to take off that Sheet which is upon the Table, and put another clean Sheet in the room thereof; and (in the Plotting of a Mannor or Lordſhip) many Sheets may be thus changed, which we call ſhifting of Paper. The manner of performing thereof is as followeth.

Example.

Suppoſe in going about to take the Plot of the Field A B C D E F G, *Fig.* 22. as in this Chapter is taught, That, you having made choice of the Angle at A for the place of beginning, and proceeded from thence to B, and from B to C, and from C to D, when you come to the angle at D, and are to draw the line D E, you want room to draw the ſame upon the Table, you muſt then do as followeth.

Firſt, through the Point D, draw the line D O, which is almoſt ſo much of the line D E, as the Table will contain: Then near the edge of the Table H M, draw a line parallel to H M, as P Q, and another line at right angles thereunto through the Point O, as O N, the point O being the faireſt point that you can bring upon your Table.

¶ And here Note, That the equal parts upon the Frame of your Table are purpoſely made for the eaſie and true drawing of theſe parallel lines.

This being done, mark this Sheet of Paper with the Figure (1) about the middle thereof, for your firſt Sheet: Then taking this Sheet off of your Table, put another clean Sheet upon the Table, and draw thereupon a line parallel to the contrary edge of the Table, as the Line R S in the 23d. Figure: Then taking your firſt Sheet of Paper, lay it upon the Table ſo, that the line P Q may exactly lie upon the line R S to the beſt advantage, as at the point O, in the 23d. Figure: Then with your Compaſs point draw ſo much of the line O D upon the clean Sheet of Paper as the Table will bear.

Having thus done, proceed with your Work upon your new Sheet, beginning at the point O, *Fig.* 23. and ſo going forward with your Work in all reſpects as before is taught in the beginning of this Chapter; as from O to E, from E to F, from F to G, and from G to A, (by this direction) ſhifting your Paper as often as you ſhall have occaſion.

II. *By the* Theodolite.

Fig. VI. PLace your Inſtrument at the angle A, and lay the Index on the Diameter thereof, turning the whole Inſtrument about, 'till through the Sights you eſpie the ſecond angle at B: Then faſtening it there, turn the Index about, 'till through the Sights you ſee the angle at G, the Index cutting 130 degrees 00 minutes, which is the quantity of the angle G A B, and the line A B containing 12 Chains 5 Links; which you muſt note down in your Field-book as formerly.

2. Remove your Inſtrument to B, and laying the Index on the Diameter, turn it about, 'till through the Sights you ſee the third angle at C, and there faſten it: Then turn the Index backward, 'till through the Sights you ſee the angle at A, the degrees cut by the Index, being 120 deg. 30 min. the quantity of the angle A B C, and the line B C containing 4 Chains 45 Links; which you muſt note in your Book as before.

3. Remove your Inſtrument to C, and lay the Index on the Diameter thereof, turning the Inſtrument about, 'till through the Sights you ſee the fourth angle at D; and there fixing it, direct the Sights back again to B, the Index cutting 137 degrees 30 minutes, and the line C D being 8 Chains 85 Links.

4. Place your Inſtrument at D, and lay the Index on the Diameter, turning the Inſtrument about, 'till through the Sights you eſpie the fifth angle at E; and there fixing it, turn the Index backward towards C, the degrees cut thereby being 120 degrees 30 minutes, and the line D E 13 Chains 4 Links; which muſt be noted in your Field-book.

5. Remove your Inſtrument to E, and lay the Index on the Diameter thereof, turning the Inſtrument about, 'till through the Sights you ſee the angle at F; and there fixing it, turn the Index backward to D, the degrees cut being 121 degrees 30 minutes, and the line E F 7 Chains 70 Links; which note down alſo.

6. Place your Inſtrument at F, and lay the Index on the Diameter thereof, turning the Inſtrument about, 'till through the Sights you ſee the angle at G; and there fixing it, turn the Index, 'till through the Sights you eſpie the former angle at E, the degrees cut being 126 degrees 30 minutes, and the length of the line F G being 5 Chains 67 Links.

7. *Laſtly*, place the Inſtrument at G, and lay the Index on the Diameter, turning the whole Inſtrument about, 'till through the Sights you eſpie the angle at A; and there fixing it, direct the Sights back again to F, the degrees cut by the Index being 143 degrees 30 minutes, and the length of the line G A 7 Chains 87 Links.

Having

Having thus made Observation at every angle of the Field in this manner, and collected the quantity of every angle, and the length of every line in your Field-book, you shall find them to stand as followeth.

	Degrees.	*Minutes.*	*Chains.*	*Links.*
A	130.	00	12	5
B	120	30	4	45
C	137	30	8	85
D	120	30	13	4
E	121	30	7	70
F	126	30	5	67
G	143	30	7	87

III. *How to Protract or lay down any Observations taken according to the Doctrine last delivered.*

Fig. VI. Consider which way your Plot will extend, and accordingly upon the Paper where you would have the Plot of your Field described, draw a Line at pleasure, as the line G A. Then place the Center of your *Protractor* upon the Point A, and (because the angle at your first Observation at A was 130 degrees 00 minutes) turn it about, 'till the line A G lie directly under 130 degrees; and then at the beginning of the *Protractor* (which is at 00 degrees, noted in the Figure thereof with the letter E) make a Mark, and through it draw the line A B, setting 12 Chains 5 Links (the length of the same line) from A to B.

2. Lay the Center of your *Protractor* upon the point B; and seeing the degrees cut at B were 120 degrees 30 minutes, therefore turn the *Protractor* about, 'till the line A B lies directly under 120 degrees 30 minutes; and then at the beginning of the degrees make a Mark, and through it draw the line B C, the length thereof being 4 Chains 45 Links.

3. Lay the Center of the *Protractor* on the point C, turning it about, 'till the line B C lies directly under 137 degrees 30 minutes, (which were the degrees cut at your Observation at C;) and then making a Mark at the beginning, or 00 degrees of your *Protractor*, through it draw the line C D, setting 8 Chains 85 Links thereon from C to D.

4. Bring the Center of your *Protractor* to the point D, turning it about, 'till the line C D lies directly under 120 degrees 30 minutes; and then making a Mark at the beginning of the *Protractor*, through it draw the line D E, and upon it set 13 Chains 4 Links from D to E.

In this manner must you deal with all the rest of the Angles; and when you come to Protract the angle at F, which is the last angle, and

and have drawn the line F G, you ſhall find it to cut the line A G, firſt drawn, in the point G, leaving the line A G to contain 7 Chains 85 Links, and the line F G 5 Chains 67 Links. And in this, practice is better then many words, and the ſight of the Figure better then a whole Chapter of information; in which Figure, you may ſee the *Protractor* lie at every angle in its true poſition.

This Work may be performed otherwiſe, by protracting your laſt Obſervation firſt. So having drawn the line A G, lay the Center of the *Protractor* on G, and the Meridian-line thereof (namely E F) on the line G A: Then (becauſe the degrees cut at your Obſervation at G were 143 degrees 30 minutes) make a Mark with your Protracting-pin againſt 143 degrees 30 minutes, and through it draw the line G F, upon which line from G to F, ſet 5 Chains 67 Links.

Then placing the Center of your *Protractor* on the point F, and the Meridian-line thereof upon the line F G, make a Mark by the edge of the *Protractor* againſt 126 degrees 30 minutes, (which were the degrees cut by the Index at your Obſervation at F) and through that point draw the line F E, ſetting 7 Chains 70 Links thereupon from F to E.

An in this manner muſt you proceed with the reſt of the lines and angles; and at laſt you ſhall find the Plot of your Field to cloſe at A, as before it did at G. And if the ſides and angles were never ſo many, the manner of the Work would be the ſame.

¶ Here note, That if in going about a Field, and meaſuring the angles thereof, with the *Theodolite* or degrees on the Frame of the Table, (as in the laſt Chapter) you ſhould meet with any angle that bendeth inwards in the Field, you muſt reckon that angle 'by thoſe rank of Figures which begin at 180, and go on 'to 190, 200, 210, *&c.* and therefore ſuch an angle will al-'ways exceed 180 degrees.

IV. *How to know whether you have taken the Angles of a Field truly.*

HAving made Obſervation of all the angles in the Field with your Inſtrument, and noted them down in your Field-book, as is done in the former part of this *Chapter*, collect the quantity of all the angles found at your ſeveral Obſervations into one Sum, and multiply 180 degrees by a number leſs by two than the number of angles in the Field: And if the product of this Multiplication be equal to the total Sum of your angles, then is your Work true, otherwiſe not.

Example.

deg.	*min.*
130	00
120	30
137	30
120	30
121	30
126	30
143	30
900	00

In the Work of this *Chapter* the angles found were as in the Margin, the Sum of them being 900 degrees 00 minutes. Now, because the Field consisted of 7 angles, you must therefore multiply 180 degrees by 5, (which is a number less by two than the number of angles in the Field) and the Product will be 900; which exactly agreeing with the Sum of all the angles in the Field as you found them by Observation, you may conclude that your Work is exactly performed.

'This Rule is general, provided that we use the Numbers grea-'ter than 180, when we have an inward angle.

V. *By the* Circumferentor.

Fig. VII. HAving shewn before the Use of the *Circumferentor* in taking the Plot of any small Inclosure several ways, yet for those kind of practices, the *Circumferentor* being no convenient Instrument, the Use thereof in those Works was only intimated, That the agreement of the several Instruments in the performance of the same thing might the better appear. Now the *Circumferentor* is a most absolute Instrument for the Surveying of any large and spacious business, as a Park, Wood, or other large Common, Field, or Champain Plain; the Use thereof differing from all that hath hitherto been delivered.

Suppose then that A B C D E F G H K were a large Field, or other Inclosure, to be Plotted by the *Circumferentor*.

1. Placing your Instrument at A, (the Flower-de-luce towards you) direct your Sights to B, the South end of the Needle cutting 191 degrees, and the Ditch, Wall, or Hedge A B containing 10 Chains 75 Links: The degrees cut, and the line measured, must be noted down in your Field-book, as in the foregoing Example.

2. Place your Instrument at B, and direct the Sights to C, the South-end of the Needle cutting 279 degrees, and the line B C containing 6 Chains 83 Links; which note down in your Field-book as before.

3. Place the Instrument at C, and direct the Sights to D, the Needle cutting 216 degrees 30 minutes, and the line C D containing 7 Chains 82 Links.

4. Place the Instrument at D, and direct the Sights to E, the Needle cutting 327 degrees, and the line D E containing 6 Chains 96 Links.

5. Place the Instrument at E, and direct the Sights to F, the Needle cutting 12 degrees 30 minutes, and the line E F containing 9 Chains 71 Links.

6. Place

6. Place the Inſtrument at F, and direct the Sights to G, the Needle cutting 342 degrees 30 minutes, and the line F G containing 7 Chains 54 Links.

7. Place the Inſtrument at G, and direct the Sights to H, the Needle cutting 98 degrees 30 minutes, and the line G H containing 7 Chains 52 Links.

8. Place the Inſtrument at H, and direct the Sights to K, the Needle cutting 71 degrees, and the line H K containing 7 Chains 78 Links.

9. Place the Inſtrument at K, and direct the Sights to A, (where you began) the Needle cutting 161 degrees 30 minutes, and the line K A containing 8 Chains 22 Links.

Having gone round the Field in this manner, and collected the degrees cut, and the lines meaſured, in the ſeveral Columns of your Field book, according to former Directions, you ſhall find them to ſtand as followeth, by which you may Protract and draw the Plot of your Field as in the next Chapter.

	Degrees.	*Minutes.*	*Chains.*	*Links.*
A	191	00	10	75
B	279	00	6	83
C	216	30	7	82
D	325	00	6	96
E	12	30	9	71
F	324	30	7	54
G	98	30	7	54
H	71	00	7	78
K	161	30	8	22

In going about a Field in this manner, you may perceive a wonderful quick diſpatch; for you are only to take notice of the degrees cut once at every angle, and not to uſe any Back-ſights, as in the foregoing Work of the *Theodolite*. But to uſe Back-ſights with the *Circumferentor* is beſt for to confirm your Work: For when you ſtand at any angle of a Field, and direct your Sights to the next, and obſerve what degrees the South-end of the Needle cutteth, if you remove your Inſtrument from this angle to the next, and look to the Mark or Angle where it laſt ſtood, with your Back-ſights, the Needle will there alſo cut the ſame degrees as before; which ought to be done, and may be without much loſs of time.

So the Inſtrument being placed at A, if you direct the Sights to B, you ſhall find the Needle to cut 191 degrees: Then removing your Inſtrument to B, if you direct the Back-ſights to A, the Needle will then alſo cut 191 degrees.

Now for diſpatch and exactneſs, (if the Needle be good, the Card well divided, and the degrees (by a good eye) truly eſtimated) the *Circumferentor* for large and ſpacious grounds is as good as any, and therefore obſerve well the manner of Protracting.

A Com-

A Compendium.

Notwithstanding the quick dispatch this Instrument maketh, there is one *Compendium* more which I will here insert, whereby (if care be taken) much labour will be saved. For whereas (by the directions here given) you are to place the Instrument at every angle, it will be sufficient now to place it but at every second angle. I will instance in the foregoing Example.

1. Placing your Instrument at A, and directing the Sights to B, you find the Needle to cut 191 degrees. Then,
2. Placing the Instrument at B, and directing the Sights to C, you find the Needle to cut 279 degrees. And,
3. Placing the Instrument at C, and directing the Sights to D, you find the Needle to cut 216 degrees.

Now, having placed your Instrument at A, and noted down the degrees cut by the Needle, which were 191, you need not go to the angle B at all, but go next to the angle C, and there place your Instrument; and directing your Sights backwards to B, you shall find the Needle to cut 279 degrees, which are the same degrees as were before cut when the Instrument was placed at B; so that the labour of placing the Instrument at B is wholly saved. Then (the Instrument still standing at C) direct the Sights to D, and the Needle will cut 216 degrees as before, which note in your Field-book. This done, remove your Instrument to E, and make Observation according to this last direction, and you shall find your Work to be the same as before. Then remove the Instrument from E to G, and from G to K, and so to every second angle, be there never so many. And here you see that half the labour is clearly saved, and the Work the same as if the Instrument had been placed at either angle.

VI. *How to Protract the foregoing Observations taken by the* Circumferentor.

THE manner of Protracting of any Observations taken by the *Circumferentor*, differeth from that of the *Theodolite*; wherefore according to the largeness of your Plot provide a Sheet of Paper, or skin of Parchment, or writing Vellom rather, as L M N O; upon which draw the line L M, and parallel thereto draw divers other lines quite through the whole Paper or Parchment, as the pricked lines in the Figure drawn between L M and N O: And let the Distance of each of these Parallels one from another be somewhat less then the breadth of the Scale of your *Protractor*. These parallel lines thus drawn do represent Meridians, and are hereafter so called:

Upon

Upon one or other of these lines (or parallel to one of them) the Meridian-line of your *Protractor* (noted in the Figure thereof, with E F) must always be laid, when you Protract any Observations taken by the *Circumferentor*, as in the Chapter before going.

Your Paper or Parchment being thus prepared, assign any point upon any of the Meridians, as A; upon which point place the Center of your *Protractor*, laying the Meridian-line thereof just upon the Meridian-line drawn upon your Paper, as you see it lie in the Figure annexed. Then look in your Field-book what degrees the Needle cut at A, which were 191 degrees: Now, because the degrees were more than 180, you must therefore lay the Semicircle of the *Protractor* downwards, and holding it there, with your Protracting-pin make a Mark against 191 degrees; through which Point, from A, draw the line A B, which contains 10 Chains 75 Links.

2. Lay the Center of the *Protractor* on the point B, with the Meridian-line thereof parallel to one of the pricked Meridians drawn upon the Paper: And seeing the degrees cut at B were more then 180, *viz.* 297, therefore the Semicircle must lie downwards; and so holding it, make a Mark against 279 degrees, and through it draw the Line B C, containing 6 Chains 83 Links.

3. Place the Center of the *Protractor* on the Point C, the Meridian-line thereof lying parallel to one of the pricked Meridians drawn on the Paper: Then the degrees cut by the Needle at your third Observation at C being above 180, namely, 216 degrees 30 minutes, therefore must the Semicircle lie downwards; then making a Mark against 216 degrees 30 minutes, through it draw the line C D, containing 7 Chains 82 Links.

4. Lay the Center of the *Protractor* upon the point D, the degrees cut by the Needle at that angle being 325; which being above 180, lay the Semicircle of the *Protractor* downwards; and against 325 degrees make a Mark with your Protracting-pin, through which point, and the angle D, draw the line D E, making it to contain 6 Chains 96 Links.

5. Remove your *Protractor* to E, laying the Meridian-line thereof upon (or parallel to) one of the Meridians drawn upon your Paper: And because the degrees cut by the Needle at this angle were less than 180, namely, 12 degrees 30 minutes, therefore lay the Semicircle of the *Protractor* upwards, and make a Mark against 12 degrees 30 minutes, through which draw the line E F, containing 9 Chains 71 Links.

6. Lay the Center of the *Protractor* upon the point F; and because the degrees to be Protracted are above 180, *viz.* 342 degrees 30 minutes, lay the Semicircle of the *Protractor* downwards, and make a Mark against 342 degrees 30 minutes, drawing the line F G, which contains 7 Chains 54 Links.

And in this manner muſt you Protract all the other angles, G, H, and K, and more, if the Field had conſiſted of more angles: Always obſerving this for a general Rule, to lay the Meridian-line of the *Protractor* upon (or parallel to) one of the Meridians drawn upon your Paper; (which the ſmall diviſions at each end of the Scale of the *Protractor* will help you to do;) and if the degrees you are to Protract be leſs then 180, (as thoſe at G, H and K are) to lay the Semicircle of the *Protractor* upwards, or from you; and if they be above 180 degrees, (as thoſe at A, B, C and D are) to lay the Semicircle downwards, as you ſee done in the Figure.

CHAP. XIX.

How to take the Plot of a Field, or other Encloſure, by going about the ſame, and meaſuring only of one Line the Plain Table.

I. *By the* Plain Table.

Fig. X. LET ABCDEFG be a Field, or other Encloſure to be Plotted. *Firſt*, make choice of ſome convenient place about the middle of the Field, from whence you may conveniently ſee all the angles thereof, as at M; where place your Table, turning it about, 'till the Needle hang directly over the Meridian-line in the Card, and there ſcrew faſt the Inſtrument. Then aſſuming any Point about the middle of your Table, repreſenting the place of your ſtanding in the Field, as M, to this Point apply the ſide of your Index, and directing the Sights thereof to the firſt angle at A, by the ſide of the Index draw the Line MA: Then direct the Sights to the angle at B, and by the ſide of the Index draw the line MB: Again, direct the Sights to C, and draw the line MC. Do thus 'till you have directed the Sights to all the other angles, as to D, E, F and G, and draw the lines MD, ME, MF and MG.

This done, meaſure the diſtance from M, the place of your ſtanding, to any of the angles of the Field, as to A, and let the diſtance from M to A be 5 Chains 80 Links: Take 5 Chains 80 links from any Scale, and ſet that diſtance upon the line MA, from M to A, and mark the Point or Angle A.

Secondly, remove your Inſtrument from M to A, and there place it, laying the Index upon the line AM, turning the Table about, 'till through the Sights you ſee a mark ſet up at M, (the place where your Inſtrument laſt ſtood) and there fix your Inſtrument: Then apply your Index to the point A, and upon that point turn it about, 'till through the Sights you ſee the next angle at B: And then by the ſide of the Index, draw a line which will cut the line

line M B (before drawn) in the point B; and the line A B will repreſent the Hedge or Wall A B, and be of equal length therewith.

Thirdly, remove your Inſtrument to B, laying the Index upon the line M B, and turn the Table about, 'till through the Sights you eſpie the Mark ſet up at M, and then fix it.

(¶ And here Note by the way, that when your Table is thus fixed at B, if you lay the Index upon the line A B, and look through the Sights, you ſhall then ſee the Angle at A, or place where your Inſtrument laſt ſtood.)

Then lay the Index upon the point B, turning it about, 'till thro' the Sights you ſee the angle at C, and draw the line by the ſide thereof, 'till it cut the line M C, which it will do in the Point C; and the line B C ſhall repreſent the Hedge B C in the Field.

Fourthly, place the Inſtrument at C, laying the Index upon the line M C, turning the Table about, 'till through the Sights you ſee your firſt mark at M, and there fix it; and laying the Index upon C, direct the Sights to D, and draw the line C D, cutting M D in D: C D doth repreſent the Hedge C D.

Fifthly, remove the Table to D, laying the Index upon the line M D, and turn the Table about, 'till you eſpie your Mark at M, and then fix it; and laying the Index upon D, direct the Sights to E, and draw the line D E, cutting M E in E.

Sixthly, place the Table at E, and lay the Index on M E, turning the Table about, 'till you eſpie the Mark at M; and fixing the Table there, remove the Index to E, and direct the Sights to the angle at F, and by the ſide thereof draw a line cutting the line M F, formerly drawn in F, which ſhall repreſent the Hedge E F.

Sevently, remove the Inſtrument to F, and lay the Index on M F, turning the Table about, 'till through the Sights you eſpie the Mark at M; and fixing it there, lay the Index upon F, directing the Sights to the angle at G, and by the ſide thereof draw a line F G, cutting M G in G.

Laſtly, place the Table at G, and lay the Index upon M G, turning it about, 'till through the Sights you ſee the Mark at M; and there fix it: Then upon G lay the Index, and direct the Sights to your firſt angle at A; and (if you have committed no former Errour) the Index will then fall juſt upon the point A, in the line A M firſt drawn. And ſo is your Plot exactly cloſed, and your Field finiſhed.

And by this way of Plotting you cannot but perceive wonderful expedition, almoſt all manner of Meaſuring being wholly omitted, and only Angular Obſervations made uſe of. And this way being well and carefully performed, is not much inferiour to any of the preceeding.

II. *By the* Theodolite.

Fig. X. HAving made choice of a place in the middle of the Field, as M, place there your *Theodolite*, turning is about, 'till the Needle hang directly over the Meridian-line of the Card; and there fixing it, direct the Sights to every respective angle of the Field, noting what degrees the Index did cut upon the Frame of the Table, which suppose to be these following.

The Sights being directed to	the Index did cut upon the Frame of the Table	*Deg.*	*Min.*
A		14	30
B		45	30
C		95	00
D		129	00
E		151	30
F		212	30
G		277	30

Having made Observation of what degrees the Index cut at every angle, and noted them down in your Field-book or Table, as you see done above, then measure the Distance from M to any angle, as to A, and you will find it to be 5 Chains 80 Links; which note down in your Field-book also in this manner,

From Station to the next Angle from the North-Eastward, 5 Chains 80 Links.

Then placing your Instrument at A, lay the Index on the Diameter of the Table, and turn it about, 'till through the Sights you see the Mark set up at M; and there fixing the Instrument, turn the Index about, 'till through the Sights you see the angle at B; and note the degrees then cut by the Index, which let be 112 degrees 30 minutes.

Then remove the Instrument to B, the Index lying on the Diameter, turning it about, 'till through the Sights you espie the Mark at M, and there fix it; turning the Index about 'till you see the angle at C, the degrees there cutting 114 degrees 00 minutes, and the rest as in the Table following.

The Instrument being placed at	and directed to M, the Index being turned about to the angle	will cut	*deg.*	*min.*
A	B		112	30
B	C		114	00
C	D		141	30
D	E		70	00
E	F		120	00
F	G		136	00
G	A		132	00

III. *How*

III. *How to Protract or lay down the Observations taken according to this Doctrine.*

Fig. IX. UPon your Paper or Parchment draw a Right line N S, representing your Meridian, or Line of North and South: About the middle thereof, as at M, assume a Point for your Station in the middle of the Field; upon which Point place the Center of your *Protractor*, the Meridian-line thereof lying exactly upon the line N S. Then having recourse to your Field-book, and finding that directing your Sights to your first angle at A, the Index cut 14 degrees 30 minutes, make a Mark against 14 degrees 30 minutes: also,

Directing the Sights to B, the Index cut 45 degrees 30 min.
Directing the Sights to C, the Index cut 95 degrees 00 min.
Directing the Sights to D, the Index cut 224 degrees 00 min.
Directing the Sights to E, the Index cut 151 degrees 30 min.
Directing the Sights to F, the Index cut 232 degrees 30 min.
Directing the Sights to G, the Index cut 277 degrees 30 min.

Against all which numbers of degrees and minutes make Marks with your Protracting-pin, close to the edge of the degrees of your *Protractor*: [Remembring, that when your degrees exceed 180, as they do at the angle F, you turn the Semicircle of your *Protractor* downwards:] And through these several Points draw right lines from the Center-Point at M, as the lines M A, M B, M C, M D, M E, M F and M G.

Then, because your measured line from M to the angle A was 5 Chains 80 Links, out of any Scale take 5 Chains 80 Links, and set it upon that line from M to A.

Again, having recourse to your Field-book, see there what degrees and minutes were cut by the Index when the Instrument was placed at the several angles A, B, C, D, &c. and finding that at the angle A, the degrees there cut were 112 degrees 30 minutes, apply the Center of your *Protractor* to the Point A, laying the Meridian-line thereof upon the line A M, and against 112 degrees 30 minutes make a Mark, through which, and the Point A, draw a line, 'till it cut the line M B in B. Then place the Center of the *Protractor* upon the point B, and the Meridian line thereof upon the line M B, and (because the degrees cut at B were 114 degrees) make a Mark against 114 degrees, and draw the line B C. Do the like for the degrees cut by the Index at the angles at C, D, E, F and G; so shall you have a perfect Draught of your Field. And this way of Surveying is both speedy and exact, if carefully managed.

CHAP. XX.

How to take the Plot of a large Champain, or other Enclosure, upon the Plain Table, *upon one Sheet of Paper.*

FOrasmuch as the way of Shifting of Paper, taught in the 18 *Chapter* of this *Book*, may seem tedious and troublesome, in respect that you may be forced to alter or shift many Sheets for one Field, (especially if you use a large Scale;) I shall therefore here shew you how you may take a large Enclosure upon one Sheet of Paper, which is thus:

Let A B C D E F G H K, *Fig.* VII. be a large Champain to be Surveyed, and you would effect it by the *Plain Table*, and bring all your Field-work upon one Sheet of Paper.

First, About the middle of your Table assign a Point at pleasure, as at O; and upon that Point, as a Center, describe two Concentrick Circles at about an Inch distance, and the outermost to be within half an Inch of the edge of your Paper, as are the two pricked Circles in the Figure.

Secondly, Consider where to begin your Work, which suppose at the angle A; and there placing your Table, and fixing it, turn the Index about upon the Center O, and direct the Sights to K, and by the side thereof draw a line from O, to the edge of the outermost Circle, and somewhat beyond it; and just without the Circle set a Cypher o: Then measuring from A to K, and finding it to contain 8 Chains 22 Links, see that number upon the Line O o between the two Circles: And before you move your Table, lay the Index to the Center O, and direct the Sights to B, and draw a Line from O to the outermost Circle, setting the Figure 1 to the end thereof: And the length A B being 10 Chains 75 Links, set that length upon the line O, 1 between the two Circles. So shall the angle o O, 1 upon your Table be equal to the angle K A B in the Field.

Thirdly, Remove your Instrument to the angle B, laying the Index upon the line O 1, and turn the Table about, 'till through the Sights you see the angle at A: Then fix the Table, and upon O turn the Index, 'till you see the angle C, and draw a line from O to the outermost Circle, setting to the end thereof the Figure 2; and the length of B C being 6 Chains 83 Links, set that length upon the line O 2 between the Circles. So shall the angle 1, O 2 upon the Table be equal to the angle A B C in the Field.

Fourthly, Remove the Table to C, laying the Index upon the line O 2; turn it about, and direct the Sights to B; then fix it, and direct the Sights to D, and draw a line from O to the outermost Circle,

Circle, ſetting to the end thereof the Figure 3; and the length C D being 7 Chains 82 Links, ſet that number upon the line O 3 between the Circles, and (becauſe the angle in the Field at C is an Exteriour or Elbow angle) make a * or other mark upon the line O 3 within the innermoſt Circle, as is done in the Figure. So ſhall the angle 2 O 3 be equal to the angle B C D.

Fifthly, Place the Table at D, laying the Index upon the line O 3, and turn the Table about, 'till you ſee the angle at C, and then fix it: Then direct the Sights to E, and draw a line from O to the outermoſt Circle, ſetting 4 at the end of it, and 6 Chains 96 Links upon it, between the Circles. And ſo is the angle 3 O 4 equal to the angle C D E.

Do thus by removing the Table to the reſpective angles in the Field, namely to E, F, G, H and K; ſtill remembring to make the point O to repreſent always the place of your ſtanding. And when you have gone about the Field, 'till you return to the angle A where you firſt began, you ſhall find the ſeveral Angles to be as in the Figure, namely,

	0 O 1		K A B	
	1 O 2		A B C	
	2 O 3		B C D*	
	3 O 4	on the Table	C D E	
The reſpective angle	4 O 5	to be equal	D E F	in the Field.
	5 O 6	to the angle	E F G*	
	6 O 7		F G H	
	7 O 8		G H K*	
	8 O 9		H K A	

And having gone round the Field, and made Obſervation at every angle as is here delivered, noting the Exteriour (or Elbow) angles D, G and K, with Marks, as * or the like, you may Protract the ſame at leiſure, according to the Directions given in the next Chapter.

How to Protract the Obſervations taken by the Directions of the laſt Chapter.

HAving made Obſervation at every angle, *Fig.* VII. and drawn lines from the Center O to the outermoſt Circle, and marked them at the ends with Arithmetical Figures, and noted the Exteriour (or Elbow) angle as is there directed; then (according to the Largeneſs of your Plot you intended) provide a Skin of Vellom or Sheet of Paper, and conſidering which way your Work will extend, accordingly make choice of a Point repreſenting your firſt angle, as the Point A: Then repair to your Circular Scheme, and finding that your firſt line marked with the Cipher o contained

8 Chains

8 Chains 22 Links, lay down a line of that length, as the line A K: Then in regard that the firſt angle in your Circular Scheme o O 1, was equal to the angle K A B in the Field, you muſt therefore upon the Point A

[Either by the 4 *Problem* of the *Firſt Book*, or by the Directions given in the Firſt and Second *Chapters* of this *Fourth Book*]

Protract an angle equal to o O 1, which will be the angle K A B; and ſetting off from A 7 Chains 75 Links (the length of the line O 1) it ſhall give you the Point B.

Then upon the Point B protract an angle equal to the angle 1 O 2, equal to A B C, and upon it ſet 6 Chains 83 Links; ſo ſhall you have the Point C.

Again, upon the Point C Protract an angle equal to the angle 2 O 3, taking out of your Scale 7 Chains 82 Links, the number belonging to the line O 3: Againſt which lines you find this mark *; which ſhews, that this angle at C muſt be Protracted outwards, or from the Field, as is the angle B C D, equal thereto.

In like manner deal with the angles D, E, F, G, H and K: And when you have come to the angle H, you ſhall (if you have truly wrought) find that the line H K would cut the line A K in its true point K, whether you had ſet off 8 Chains 22 Links thereupon or not.

CHAP. XXI.

How to take the true Plot of a Foreſt, Chaſe, Wood, Park, or other large Incloſure, by the Circumferentor *or* Theodolite, *by a different way from the former; and to know (before you begin to Protract) whether your Plot will cloſe or not.*

THIS way of Surveying is the moſt exact and abſolute of all others for the Surveying of Counties, and all other large and capacious Works, as of Iſlands, Plantations, &c. For the performing of this Work, the Card of the *Circumferentor* muſt be divided into four Quadrants or Quarters, each containing 90 degrees, and numbred by 10, 20, 30, &c. to 90, beginning at the Meridian, and ſo reckoning to the Eaſt and Weſt Points, as is expreſſed in the Figure of the Card mentioned in the Tenth *Chapter* of the *Second Book*, *Fig.* IV.

Your Inſtrument being provided with ſuch a Card as I juſt now mentioned, you may proceed to take the Plot of the ground you intend in manner following. But firſt provide your Field-book, which (in

(in this caſe) muſt be ruled with Red-ink into ſix Columns. The firſt of which muſt be ſo broad as to contain the number of degrees, and the quarter of the Compaſs in which the degrees are cut by the South-end of the Needle. The ſecond Column is for the Chains and Links which every ſide of the Field containeth. The four other Columns, which have written at the head thereof, *North*, *South*, *Eaſt*, *Weſt*, are to hold a certain number of Chains and Links, by the addition of which you may examine your Work, and diſcover whether your Plot will cloſe or not, before you proceed to Protract it.

I. *The manner of Working.*

Fig. XI. LEt A B C D E F G H K be a Field to be meaſured. Having placed marks at every angle thereof; *firſt*, place your Inſtrument at A, (the Flower-de-luce towards you) and direct the Sights to B, the South-end of the Needle cutting 54 degrees in the South-weſt Quadrant; and let the length of the line A B be 5 Chains 12 Links. Now you muſt (in the *firſt* Column of your Field-book) ſet down S W 54 degrees 0 min. repreſenting South-weſt 54 degrees 0 min. and in the ſecond Column ſet down 5, 12, repreſenting 5 Chains 12 Links.

Secondly, place your Inſtrument at B, and direct the Sights to C, the Needle cutting North-weſt 45 degrees, and the line B C containing 2 Chains 89 Links.

Thirdly, place your Inſtrument at C, and direct the Sights to D, the Needle cutting North-weſt 76 degrees, and the line C D containing 3 Chains 35 Links.

Fourthly, place your Inſtrument at D, and direct the Sights to E, the Needle cutting North-eaſt 31 degrees, and the line D E containing 4 Chains 55 Links.

Fifthly, place your Inſtrument at E, and direct the Sights to F, the Needle cutting North-eaſt 56 degrees, and the line E F containing 2 Chains 67 Links.

Sixthly, place your Inſtrument at F, and direct the Sights to G, the Needle cutting North-eaſt 21 degrees, and the line F G containing 2 Chains 24 Links.

Seventhly, place your Inſtrument at G, and direct the Sights to H, the Needle cutting South-eaſt 51 degrees, and the line G H containing 2 Chains 95 Links.

Eighthly, place your Inſtrument at H, and direct the Sights to K, the Needle cutting South-eaſt 34 degrees, and the line H K containing 3 Chains 25 Links.

Laſtly, place your Inſtrument at K, and direct the Sights to A, the Needle cutting South-weſt 4 degrees, and the line K A containing 2 Chains 95 Links.

Having thus made Obſervation of all the Angles, and meaſured all the ſides with your Chain, and ſet them down in your Field-book you ſhall find them to ſtand as followeth.

The Figure of your Field-book.

		deg. m.	*C. L.*	*North.*	*South.*	*Eaſt.*	*Weſt.*
A	S W	54 00	5. 12				
B	N W	45 00	2. 89				
C	N W	76 00	3. 35				
D	N E	31 00	4. 55				
E	N E	56 00	2. 67				
F	N E	21 00	2. 24				
G	S E	51 00	2. 95				
H	S E	34 00	3. 25				
K	S W	4 00	2. 95				

II. *How to Examine your Work, whether you have truly wrought or not.*

YOur Work being finiſhed, the degrees cut by the Needle, and the length of the ſides meaſured by the Chain ſet down in the firſt and ſecond Columns of your Field-book, you may proceed to Protracting: But if you deſire to be ſatisfied of the truth of your Work before, you may by help of the lines of Sines and Numbers, or by the Table of Sines and Logarithms in the *Third Book*, very ſpeedily make trial, and diſcover wherein you have erred, and amend that Errour before you proceed farther. The proportion is this:

Firſt,

As the Radius, or Sine of 90 degrees,
is to the length of the ſide of the Field in Chains and Links,
So is the Sine of the degrees cut by the Needle,
to the length in the Parallel in Chains and Links.

'Wherefore extend the Compaſſes from the Sine of 90, to the 'length of the ſide of the Field in the line of Numbers; the ſame 'extent will reach from the Sine of the Degrees cut by the Needle to 'the length in the Parallel.

Secondly,

As the Radius, or Sine of 90 degrees,
is to the length of the ſide of the Field in Chains and Links,

So

So is the Sine of the Complement of the deg. cut by the Needle to the length in the Meridian in Chains and Links.

'Wherefore extend the Compaſſes from the Sine of 90, to the 'length of the ſide of the Field in the line of Numbers; the ſame ex-'tent will reach from the Sine of the Degrees cut by the Needle to 'the length in the Parallel.

'But when the length is near 10 Chains, this extending will be 'not ſo convenient, unleſs the Sines and Numbers are back to back, 'as hinted at in *Chap.* 4. *Book* 2. But if your Compaſſes are long 'enough to reach from the Radius to the middle 9, the work will 'do very well: But if not, extend the Compaſſes from the firſt 'Term in the Proportion to the Third, and that extent will reach 'from the Second to the Fourth.

¶ Note, That the two Columns in your Field-book which are noted with *North* and *South* are the Meridian Columns, and the two Columns noted with *Eaſt* and *Weſt* are the Parallel Columns: That is to ſay, the line of *North* and *South*, noted in the following Figure with N S, is called the Meridian; and the line noted with E W, in the ſame Figure, is called the Parallel.

EXAMPLE.

Let it be required to examine whether the degrees be rightly taken, and the ſides truly meaſured in this Figure, before you begin to Protract.

Your degrees being Noted, and your lengths of Lines orderly placed in your Field-book, we proceed to examine the truth thereof thus:

Firſt, The degrees cut by the Needle, when the Inſtrument was placed at A, being S W 54 degrees, and the length of the line A B being 5 Chains 12 Links, if you extend the Compaſſes from the Sine of 90 deg. to 5 Chains 12 Links in the line of Numbers, that extent will reach from the Sine of 54 degrees, which were the degrees cut by the Needle at A, to 4 Chains 14 Links in the line of Numbers, which is the Diſtance in the Parallel; and alſo the ſame extent will reach from the Sine of 36 degrees, which is the Complement of the degrees cut by the Needle at A, to 2 Chains 97 Links in the line of Numbers, which is the Diſtance in the Meridian; Wherefore (becauſe the quarter of the Compaſs was South-weſt) ſet 4 Chains 14 Links (which is the Diſtance in the Parallel) in the Column of Weſt, and alſo ſet 2 Chains 97 Links (which is the Diſtance in the Meridian) in the Column of South; and ſo have you done with your firſt Station at A.

Secondly, The degrees cut by the Needle, when the Inſtrument was placed at B, being N W 45, and the length of the line B C being

being 2 Chains 89 Links, if you extend the Compaſſes from the Sine of 90 degrees to 2 Chains 89 Links in the line of Numbers, that extent will reach from the Sine of 45 degrees, which were the degrees cut by the Needle at B, to 2 Chains 4 Links in the line of Numbers, which is the Diſtance in the Parallel; and alſo the ſame extent will reach from the Sine of 45, which is the Complement of the degrees cut by the Needle at B, to 2 Chains 4 Links in the line of Numbers, which is the Diſtance in the Meridian: Wherefore (becauſe the quarter of the Compaſs was North weſt) ſet 2 Chains 4 Links (which is the Diſtance in the Parallel) in the Column of Weſt, and alſo ſet 2 Chains 4 Links (which is the Diſtance in the Meridian) in the Column of North; and ſo have you done with your ſecond Station at B.

Thirdly, The degrees cut by the Needle, when the Inſtrument was placed at C, being N W 76, and the length of the line C D being 3 Chains 35 Links, if you extend the Compaſſes from the Sine of 90 degrees to 3 Chains 35 Links in the line of Numbers, that extent will reach from the Sine of 76, which were the degree cut by the Needle at C, to 3 Chains 25 Links in the line of Numbers, which is the Diſtance in the Parallel; and alſo the ſame extent will reach from the Sine of 14 degrees, which is the Complement of the deg. cut by the Needle at C, to 0 Chains 83 Links in the line of Numbers, which is the Diſtance in the Meridian: Wherefore (becauſe the quarter of the Compaſs was North-weſt) let 3 Chains 25 Links (which is the Diſtance in the Parallel) in the Column of Weſt, and alſo ſet 0 Chains 83 Links (which is the Diſtance in the Meridian) in the Column of North; and ſo have you done with your third Station at C.

Fourthly, The degrees cut by the Needle, when the Inſtrument was placed at D, being N E 31 degrees, and the length of the line D E being 4 Chains 55 Links, if you extend the Compaſſes from the Sine of 90 degrees to 4 Chains 55 Links in the line of Numbers, that extent will reach from the Sine of 31 degrees, which were the degrees cut by the Needle at D, to 2 Chains 35 Links in the line of Numbers, which is the Diſtance in the Parallel; and alſo the ſame extent will reach from the Sine of 59 degrees, which is the Complement of the degrees cut by the Needle at D, to 3 Chains 93 Links in the line of Numbers, which is the Diſtance in the Meridian: Wherefore (becauſe the quarter of the Compaſs was North-eaſt) ſet 2 Chains 35 Links (which is the Diſtance in the Parallel) in the Column of Eaſt, and alſo ſet 3 Chains 93 Links (which is the Diſtance in the Meridian) in the Column of North; and ſo have you done with your fourth Station at D.

Fifthly, The degrees cut by the Needle, when the Inſtrument was placed at E, being N E 56, and the length of the line E F being 2 Chains 67 Links, if you extend the Compaſſes from the Sine of 90 degrees to 2 Chains 67 Links in the line of Numbers, that extent will reach from the Sine of 56 degrees, which were the degrees cut by the Needle at E, to 2 Chains 22 Links in the line of Numbers, which

which is the Distance in the Parallel; and also the same extent will reach from the Sine of 34, which is the Complement of the degrees cut by the Needle at E, to 1 Chain 50 Links in the line of Numbers, which is the Distance in the Meridian: Wherefore (because the quarter of the Compass was North-East) set 2 Chains 22 Links (which is the Distance in the Parallel) in the Column of East, and also set 1 Chain 50 Links (which is the Distance in the Meridian) in the Column of North; and so have you done with your fifth Station at E.

Sixthly, The degrees cut by the Needle, when the Instrument was placed at F, being N E 21 degrees, and the length of the line F G being 2 Chains 24 Links, if you extend the Compasses from the Sine of 90 degrees to 2 Chains 24 Links in the line of Numbers that extent will reach from the Sine of 21 degrees, which were the degrees cut by the Needle at F, to 0 Chains 80 Links in the line of Numbers, which is the Distance in the Parallel; and also the same extent will reach from the Sine of 69 degrees, which is the Complement of the degrees cut by the Needle at F, to 2 Chains 10 Links in the line of Numbers, which is the Distance in the Meridian: Wherefore (because the quarter of the Compass was North-east) set 0 Chains 80 Links (which is the Distance in the Parallel) in the Column of East, and also set 2 Chains 10 Links (which is the Distance in the Meridian) in the Column of North; and so have you done with your sixth Station at F.

Seventhly, The degrees cut by the Needle, when the Instrument was placed at G, being S E 51 degrees, and the length of the line G H being 2 Chains 95 Links, if you extend the Compasses from the Sine of 90 degrees to 2 Chains 95 Links in the line of Numbers, that extent will reach from the Sine of 51 degrees, which were the degrees cut by the Needle at G, to 2 Chains 30 Links in the line of Numbers, which is the Distance in the Parallel; and also the same extent will reach from the Sine of 39, which is the Complement of the degrees cut by the Needle at G, to 1 Chain 83 Links in the line of Numbers, which is the Distance in the Meridian: Wherefore (because the quarter of the Compass was South-east) set 2 Chains 30 Links (which is the Distance in the Parallel) in the Column of East, and also set 1 Chain 83 Links (which is the Distance in the Meridian) in the Column of South; and so have you done with your seventh Station at G.

Eighthly, The degrees cut by the Needle, when the Instrument was placed at H, being S E 34 degrees, and the length of the line H K being 3 Chains 25 Links, if you extend the Compasses from the Sine of 90 degrees to 3 Chains 25 Links in the line of Numbers, that extent will reach from the Sine of 34 degrees, which were the degrees cut by the Needle at H, to 1 Chain 82 Links in the line of Numbers, which is the Distance in the Parallel; and also the same extent will reach from the Sine of 56, which is the Complement of the degrees cut by the Needle at H, to 2 Chains 68 Links in the line of Numbers, which is the Distance in the Meridian: Where-

fore (becauſe the quarter of the Compaſs was South-eaſt) ſet 1 Chain 82 Links (which is the Diſtance in the Parallel) in the Column of Eaſt, and alſo ſet 2 Chains 68 Links (which is the Diſtance in the Meridian) in the Column of South; and ſo have you done with your eighth Station at H.

Ninthly, The degrees cut by the Needle, when the Inſtrument was placed at K, being SW 4 degrees, and the length of the line K A being 2 Chains 95 Links, if you extend the Compaſſes from the Sine of 90 degrees, to 2 Chains 95 Links in the line of Numbers, that extent will reach from the Sine of 4 degrees, which were the degrees cut by the Needle at K, to 0 Chains 6 Links in the line of Numbers, which is the Diſtance in the Parallel; and alſo the ſame extent will reach from the Sine of 86, which is the Complement of the degrees cut by the Needle at K, to 2 Chains 92 Links in the line of Numbers, which is the Diſtance in the Meridian: Wherefore (becauſe the quarter of the Compaſs was South-weſt) ſet 0 Chains 6 Links (which is the Diſtance in the Parallel) in the Column of Weſt, and alſo ſet 2 Chains 92 Links (which is the Diſtance in the Meridian) in the Column of South; and ſo have you done with your ninth Station at K.

Having thus gone over every of your Angles and Sides, as you ſee here done, and noted them down in your Field-book under their reſpective Titles of *North*, *South*, *Eaſt* and *Weſt*, you ſhall find them to ſtand in the Field-Book, as followeth.

The Figure of your Field-book.

		deg. m.	*C. L.*	*North.*	*South.*	*Eaſt.*	*Weſt.*
A	S W	54 00	5. 12		2.97		4.14
B	N W	45 00	2. 89	2.04			2.04
C	N W	76 00	3. 35	0.83			3.25
D	N E	31 00	4. 55	3.93		2.35	
E	N E	56 00	2. 67	1.50		2.22	
F	N E	21 00	2. 24	2.10		0.80	
G	S E	51 00	2. 95		1.83	2.30	
H	S E	34 00	3. 25		2.68	1.82	
K	S W	4 00	2. 95		2.92		0.06
			Sum	10.40	10.40	9. 49	9.49

This done, add all the Figures in the *North* Column together, and you ſhall find that they make 10 Chains 40 Links; alſo add the *South* Colum, and they make 10 Chains 40 Links: Then add the *Eaſt* Column, and they make 9 Chains 49 Links; *laſtly*, add the *Weſt* Column, and they alſo make 9 Chains 49 Links.

Now

Now becauſe the Sum of the *North* Column, and the Sum of the *South* Column, are all one without any difference, and alſo the Sum of the *Eaſt* Column, and the Sum of the *Weſt* Column are equal, you may be aſſured that your Work is true: But if the Sums of the *North* and *South* Columns had differ'd, your Angles or Sides had been falſly obſerved; and alſo if the Sums of the *Eaſt* and *Weſt* Columns had differ'd, it had diſcovered an errour: But being they agree, you may be aſſured you Work is true, and therefore may with confidence proceed to Protraction, according to the Directions following.

How to Protract any Obſervations taken according to the Directions of the laſt Chapter.

Fig. XI. UPon a Sheet of Paper or Parchment draw firſt a line, as SN, repreſenting the Meridian, and at right angles here to another line EW, repreſenting the Parallel: Then laying your Field-book before you, you ſhall find in the *South* Column 2. 97; wherefore take in your Compaſſes 2 Chains 97 Links, and place it upon the Meridian from A to 1.

Secondly, In the *North* Column you find 2. 04: Take 2 Chains 4 Links in your Compaſſes, and ſet that Diſtance upon the Meridian from 1 to 2. And becauſe you change your Column from *South* to *North*, you muſt ſet your 2 Chains 4 Links from 1 to 2 downwards towards the N.

Thirdly, In the *North* Column you ſhall find 0. 93: Take 0 Chains 93 Links in your Compaſſes, and ſet that Diſtance upon the Meridian from 2 to 3.

Fourthly, In the *North* Column you ſhall find 3. 93: Take 3 Chains 93 Links in your Compaſſes, and ſet that Diſtance upon the Meridian from 3 to 4.

Fifthly, In the *North* Column you ſhall find 1. 50: Take 1 Chain 50 Links in your Compaſſes, and ſet that Diſtance upon the Meridian from 4 to 5.

Sixthly, In the *North* Column you ſhall find 2. 10: Take 2 Chains 10 Links in your Compaſſes, and ſet that Diſtance upon the Meridian from 5 to 6.

Seventhly, In the *South* Column you ſhall find 1. 83: Take 1 Chain 83 Links in your Compaſſes, and ſet that Diſtance upon the Meridian from 6 to 7. And here again, becauſe you change your Column from *North* to *South*, you muſt ſet your 1 Chain 83 Links from 6 to 7 upwards towards the *South*.

Eighthly, In the *South* Column you ſhall find 2. 68: Take 2 Chains 68 Links in your Compaſſes, and ſet that Diſtance upon the Meridian from 7 to 8.

Ninthly,

Ninthly, In the *South* Column you ſhall find 2. 92: Take 2 Chains 92 Links in your Compaſſes, and ſet that Diſtance upon the Meridian from 8 to A, where it will exactly fall, if you have truly wrought.

Thus have you found the Points 1. 2. 3. 4. 5. 6. 7 and 8. upon the Meridian N S: Through every of which Points draw obſcure Lines with Black lead, or ſuch like, parallel to the Parallel E W; as the Lines 1 B, 2 C, 3 D, 4 E, 5 F, 6 G, 7 H, 8 K.

This done, repair again to your Field-book, where in the *Weſt* Column you ſhall find 4. 14: Take 4 Chains 14 Links in your Compaſſes, and ſet that Diſtance upon the Parallel from A to 1.

Secondly, In the *Weſt* you ſhall find 2. 04: Take 2 Chains 04 Links in your Compaſſes, and ſet that Diſtance upon the Parallel from 1 to 2.

Thirdly, In the *Weſt* you ſhall find 3. 25: Take 3 Chains 25 Links in your Compaſſes, and ſet that Diſtance upon the Parallel from 2 to 3.

Fourthly, In the *Eaſt* you ſhall find 2. 35: Take 2 Chains 35 Links in your Compaſſes, and ſet that Diſtance upon the Parallel from 3 to 4. And here, beeauſe you change your Column from *Weſt* to *Eaſt*, you muſt ſet your 2 Chains 35 Links from 3 to 4 backward towards A.

Fifthly, In the *Eaſt* you ſhall find 2. 22: Take 2 Chains 22 Links in your Compaſſes, and ſet that Diſtance upon the Parallel from 4 to 5.

Sixthly, In the *Eaſt* you ſhall find 0. 80: Take 0 Chains 80 Links in your Compaſſes, and ſet that Diſtance upon the Parallel from 5 to 6.

Seventhly, In the *Eaſt* you ſhall find 2. 30: Take 2 Chains 30 Links in your Compaſſes, and ſet that Diſtance upon the Parallel from 6 to 7.

Eighthly, In the *Eaſt* you ſhall find 1. 82: Take 1 Chain 82 Links in your Compaſſes, and ſet that Diſtance upon the Parallel from 7 to 8.

Ninthly, In the *Weſt* you ſhall find 0. 06: Take 0 Chains 06 Links in your Compaſſes, and ſet that Diſtance upon the Parallel from 8 to A, where it will alſo exactly fall, if you have truly wrought.

Thus have you found the Points 1. 2. 3. 4. 5. 6. 7 and 8. upon the Parallel E W: Through every of which Points draw obſcure Lines with Black-lead, or ſuch like, parallel to the Meridian S N; as the Lines 1 B, 2 C, 3 D, 4 E, 5 F, 6 G, 7 H, 8 K.

This

This done, you shall find that the line 1 B which is drawn Parallel to the Parallel E W, and the line 1 B which is drawn Parallel to the Meridian S N, will cross one another in the point B: Wherefore a line drawn from A to B shall represent the side of the Field A B; and if you have wrought truly, you shall find it to contain 5 Chains 12 Links.

Likewise the Lines 2 C and 2 C cross one another in the Point C.
Likewise the Lines 3 D and 3 D cross one another in the Point D.
Likewise the Lines 4 E and 4 E cross one another in the Point E.
Likewise the Lines 5 F and 5 F cross one another in the Point F.
Likewise the Lines 6 G and 6 G cross one another in the Point G.
Likewise the Lines 7 H and 7 H cross one another in the Point H.
Likewise the Lines 8 K and 8 K cross one another in the Point K.

Now if you draw the lines A B, B C, C D, D E, E F, F G, G H, H K, and K A, you shall have upon your Paper or Parchment the true and exact Figure of the Land you Survey'd. And this way for exactness exceedeth any other that I know of.

CHAP. XXII.

How to take the true Plot of a Wood, *or other* Enclosure, *into which you cannot come to fix your* Instrument, *or to Measure your Distances.*

I. *By the* Plain Table.

LET A B C D E F *(Fig.* XXIV.*)* be a Wood, first assign a place to begin at, without the Wood, which let be at the angle at A: From whence, measure to a Mark set up at the next angle at B, which Distance let be 2 Chains 05 Links.

Secondly, Place your Instrument at B, and assign some convenient point upon your Table to represent the same, and draw a line thereupon, set upon it your Measures distance from B to A.

Thirdly, Lay your Ruler and Sights upon this line, and move the Table about 'till you see your Mark at A, and there fix the Table: Then,

Fourthly, Lay your Ruler to the point B, and direct your Sights to a Mark set up at C, and by the edge of it draw a line, and Measure the distance from B to C, which suppose to be 1 Chain 48 Links, which distance set from B to C.

Fifthly, Remove your Table to C, laying the Ruler upon the line C B, and turn it about 'till you see your Mark at B, and then fix it;

and turn the Ruler about upon the point C, 'till you ſee a Mark ſet up at D, and by the ſide thereof draw a line, and Meaſure the diſtance C D, which ſuppoſe to be 2 Chains 06 Links, which diſtance ſet upon the line from C to D.

Sixthly, Remove your Table to D, laying the Ruler upon D C, and turn the Table about, 'till you ſee your Mark C, and there fix it, turning the Index about upon D, 'till you ſee a Mark ſet up at E, drawing a line by the ſide of it: Then meaſure the diſtance from D to E, which let be 4 Chains 75 Links, which ſet upon the line from D to E.

Seventhly, Remove your Table to E, laying the Index upon the line E D, and turn the Table about, 'till you ſee the mark at D, and there fix it, turning the Index about upon the point E, 'till you ſee a Mark ſet up at F, drawing a line by the ſide of it. Then meaſuring the diſtance from E to F, ſuppoſe 2 Chains 15 Links, ſet that diſtance upon the line from E to F.

Laſtly, Remove your Table to F, laying the Index upon the line F E, and turn the Table about, 'till through the Sights you ſee the Mark at E, and then fix the Table, and turning the Index upon the point F, direct your Sights to your Mark firſt ſet up at A, and meaſure the diſtance F A, which will be 2 Chains 62 Links. And ſo is your Wood incloſed.

II. *By the* Theodolite.

'HAving aſſigned an angle without the Wood whereat to begin, as at A, (*Fig.* 24.) ſet your Inſtrument at the next angle at 'B; then meaſure the diſtance from A to B, which ſuppoſe 2 Chains '05 Links, which ſet down: Then turn the Inſtrument about, 'till 'through the fixt Sights, you ſee your next Mark at C, and then fix it, 'and turn the Index about 'till you ſee your laſt Mark at A, and 'note what Degrees are cut, which we will ſuppoſe to be 93 de-'grees, which ſet down in your Book.

'Then meaſure the Diſtance from B to C, ſuppoſe to be 1 Chain '48 Links, which ſet down: Then ſet up your Inſtrument at C, 'turning it about upon the Staff, 'till through the fixt Sights you ſee your 'next Mark D, and then fix it, turning the Index about, 'till thro' 'the Sights you ſee your Mark at B, where we ſuppoſe it will cut 257 de-'grees. And working in this manner at every of the other angles, 'and meaſuring the ſeveral diſtances, you will find them to be as in 'this Table.

From	to	is *C. L.*	and the Angle	is *Deg.*
A	B	2. 05	ABC	93
B	C	1. 43	BCD	257
C	D	2. 06	CDE	44
D	E	4. 75	DEF	79
E	F	2. 15	EFA	145
F	A	2. 62	FAB	97

III. *How*

III. *How to Protract according to these Observations.*

'I Need say nothing concerning the Protraction hereof, it being 'performed in the same manner as the Protraction in *Chap.* 18. 'But the very sight of *Fig.* X. will be better Direction, than a whole '*Chapter* of Information, and therefore to it I refer it.

CHAP. XXIII.

How to take the Plot of a whole Mannor, or of divers parcels of Land lying together, whether Wood-lands or Champain Plains.

I. *By the* Plain Table.

Fig. XIII. ALthough practice, in the performance hereof, be better than many words, and that the rules already delivered are of sufficient extent to perform the work of this *Chapter*; yet (for farther satisfaction in this particular) I will herein deliver the most sure and compendious way I can imagine.

Suppose therefore that the following Figure ALMNPQSTY XGH and K were part of a Mannor, or divers parcels of land lying together, and that it were required to take the plot thereof upon your *Plain Table.*

Now the best way (in my opinion) is, first to go round about the whole quantity to be measured, and draw upon your Table a perfect Plot thereof, as if it were one entire Field: (which you may do by the 13 *Chapter* of this *Book*:) and then to make separation and division thereof in an orderly way, as is taught in this *Chapter.* But before you begin your Work, it will be very necessary to ride or walk about the whole Mannor, or at least so much as you are to Survey, that you may be the better acquainted with the several Bounders: And in your Passage, you ought to take special Notice of all eminent things lying in your way, as Churches, Houses, Mills, High-ways, Rivers, *&c.* which will much help you. Also in this your Passage, it were necessary to take Notice of some convenient place to begin your Work, as followeth.

Having made choice of some convenient place in the Periphery or outward part of the Mannor, as at A, place there your Table, turning it about, 'till the Needle hang over the Meridian-line in the Card, and there fix it: Then upon the Table (with most convenience) assign any point at pleasure, as A; unto which point lay the Index, and

and turn it about, 'till through the Sights you ſee a Mark ſet up at the next angle at L: Then by the Side of the Index draw the line A L, which ſuppoſe to contain 8 Chains 68 Links: Take theſe 8 Chains 68 Links from any Scale, and place that length upon your Table from A to L.

2. Bring your Inſtrument to L, and lay the Index upon the line L A, turning the whole Table about, 'till through the Sights you ſee a Mark ſet up at A, where your Table laſt ſtood, and there fix it, ſo will the Needle hang directly over the Meridian-line in the Card as before: Then lay the Index upon the point L, and turn it about, 'till through the Sights you ſee a Mark ſet up at the next angle at M, and draw a line by the ſide of the Index, which ſuppoſe to contain 6 Chains 55 Links: This length being taken from the ſame Scale as the former line was, will reach upon your Table from the point L unto M.

3. Remove your Table to M, and lay the Index upon the line M L, turning the Table about, 'till through the Sights you eſpie a Mark ſet up at the angle L, where your Table laſt ſtood, and there fixing it, you ſhall ſtill find the Needle to hang directly over the Meridian-line, if you proceed truly in your Work: Then laying the Index to the point M, turn it about, 'till through the Sights you eſpie ſome Mark ſet up at the next angle at N, and draw a line by the ſide of the Index: Then meaſuring with your Chain from M to N, you ſhall find it to contain 7 Chains 27 Links; which take from the ſame Scale as before, and place the length thereof upon your Table from M unto N.

4. Place your Inſtrument at N, laying the Index upon the line N M, and turn the Table about, 'till through the Sights you ſee a Mark ſet up at your former Station at M, and there fix the Table, ſo will the Needle hang over the Meridian-line as before: Then turn the Index about upon the point N, 'till through the Sights you eſpie the next angle at P, and draw a line by the ſide thereof: Then meaſure the diſtance N P 9 Chains 32 Links, which take from the Scale, and ſet it upon your Table from N unto P.

In this manner muſt you go round about the whole Mannor, making Obſervation at every angle thereof, as at P Q S T Y X G H and K, and ſetting down the length of every line upon your Table as you find it by meaſuring with your Chain, you ſhall have upon your Table the Figure of one large Plain, which muſt include all the reſt of the Work: And in thus going about you ſhall (if you have truly wrought all the way) find your Plot to cloſe exactly in the point *A*, where you began; but if it do not, go over your Work again, for otherwiſe all that you do afterwards within the ſame will be falſe.

¶ Here Note, That if one ſheet of Paper will not contain your whole Plot, you muſt then ſhift your Paper as is taught in the 18 *Chapter* of this Book.

Having

Having thus drawn the true Plot of the outward bounds or Periphery of the whole Mannor upon your Table, as the Figure A L M N P Q S T Y X G H and K, and exactly cloſed your Plot at A where you began, you may proceed now to lay out the ſeveral Cloſes therein contained, in this manner.

1. Place your Table at A, laying the Index and Sights upon the line A L before drawn, and turn it about 'till through the Sights you eſpie the angle L; and there fixing it, the Needle will hang directly over the Meridian-line in the Card: Then turn the Index about upon the point A, 'till through the Sights you eſpie a Mark ſet up at the angle B, and by the ſide of the Index draw the line A B, containing 6 Chains 43 Links.

2. Remove the Table to B, laying the Index on the line B A, and turn the Table about 'till through the Sights you ſee the angle A: Then fix it, and turn the Index about upon B, 'till you ſee the next angle at C, drawing the line B C by the ſide of the Index, which ſuppoſe to contain 8 Chains 5 Links.

3. Place the Table at C, laying the Index upon the line C B, and turn it about 'till through the Sights you ſee your former Station at B; and there fixing it, turn the Index about upon the point C, 'till through the Sights you ſee the angle at E, and draw the line C E, containing 10 Chains 22 Links, which ſet from C to E; and again (before you move your Table) direct the Sights to O, and draw the line O C, containing 6 Chains 64 Links, which take from your Scale, and ſet from C to O: And (becauſe O is the next angle to the bounder) you may (without placing your Inſtrument at O, or meaſuring the diſtance O N) draw the line O N upon your Table, which (if the reſt of the Work be true) will contain 4 Chains 45 Links.

4. Remove your Table to E, laying the Index upon the line E C, and turn the Table about 'till through the Sights you ſee the angle at C: Then fix it, and turn the Index about upon the point E, 'till you eſpie the next angle at F, and draw the line E F containing 5 Chains 50 Links, which ſet from E to F. Now (becauſe the angle at F is the next angle to the bounder) you may draw the line F G upon your Table without any further trouble, which (if the reſt of your work be true) will contain 6 Chains 68 Links.

5 Remove your Inſtrument to T, laying the Index upon the line T S, and turn it about 'till through the Sights you eſpie the angle at S; and there fixing it, turn the Index about upon the point T, 'till through the Sights you eſpie the next angle at V, and by the ſide of the Index draw the line T V, containing 6 Chains 15 Links, which ſet upon the Table from T to V. Now (becauſe V is the angle next the bounder) you may only draw the line V G, without placing your Inſtrument at V, or meaſuring the diſtance V G, upon the ground, which (if the reſt of the work be true) will contain 6 Chains 38 Links.

6 Bring your Inſtrnment to Q, and lay the Index upon the line PQ, turning the Table about 'till through the Sights you ſee the angle at P: Then fixing the Table there, turn the Index about upon the point Q, 'till through the Sights you eſpie the angle at R, and by the ſide of the Index draw the line Q R, containing 10 Chains 75 Links, which ſet from Q to R.

Laſtly, Bring your Table to R, and laying the Index on the line Q R, turn the Table about 'till through the Sights you ſee the angle at Q, and there fix it: Then turn the Index about upon the point R, 'till through the Sights you eſpie the angle at D, and draw the line R D, which (if the reſt of the work be true) will contain 5 Chains 3 Links.

Thus have you an exact and perfect draught of the whole Mannor, or of ſeveral Incloſures; in the performance whereof I have been ſomething large, becauſe I would ſhew the moſt natural way firſt: But the ſame thing may be performed with more brevity as followeth, wherein (if you mark it well) you ſhall plainly perceive that half the work will be abbreviated, and the ſame thing effected with almoſt half the meaſuring.

1. Having made choice of the angle A to begin your Work, place your Table there, turning it about 'till the Needle hang directly over the Meridian-line in the Card, and there fix it: Then aſſign any point upon the Table for your beginning Station, as the point A, and laying the Index to this point, turn it about 'till through the Sights you eſpie the next angle at L: Then draw the line A L, containing 8 Chains 68 Links, which take from your Scale, and ſet from A to L: And alſo (before you move your Table) direct the Sights to B and K, and by the ſide of the Index draw the Lines A B, and A K; but you need not meaſure the lengths of them.

2. Then go forward with your Work as in the former part of this *Chapter*, placing your Table at the angles L M and N; and when you come to N, and have drawn the line N P, you may (before you move your Table) draw the line N O. but not meaſure it.

3. Alſo when you come to the angle Q, and have drawn the line Q S, you may draw the line Q R alſo, at once placing of the Table.

4. When you come to obſerve at the angle T, and have drawn the line T Y, you may at the ſame time alſo draw the line T V, but need not meaſure it.

5. When you come to the angle G, and have drawn the line G H, you may alſo draw the line G V, which will cut the line T V in the point V; and at the ſame time alſo you may draw the line G F, containing 6 Chains 68 Links.

Having thus gone round the whole Mannor, and made a Plot of the outward part or Periphery thereof, and alſo drawn the lines A B, N O, Q R, T V, G V and G F, as you went along the bounder, the remainder of the Work will (by this means) be much abbreviated, for you have no more to do, but

1. To

1. To place your Table at F, laying the Index upon the line F G, and to turn it about 'till through the Sights you eſpie the angle at G: And fixing it there, direct the Sights to E, and draw the line E F, containing 5 Chains 50 Links.

2. Place the Table at E, and lay the Index on the line E F, turning the Table about 'till you ſee through the Sights the angle F; then fix it, and turn the Index about upon the point E 'till through the Sights you eſpie the angle at C, and by the ſide of the Index draw the line E D C, which containeth 10 Chains 22 Links. Then, becauſe from C to D there are 4 Chains, ſet 4 Chains from C to D, and draw the liné D R, which will cut the line Q R in the point R, leaving the line D R to contain 5 Chains 3 Links.

Laſtly, Place the Table at C, laying the Index on the line C E, turning it about 'till through the Sights you ſee the angle at E; and there fixing it, turn the Index about upon the point C, and direct the Sights to B and O, drawing the lines C B and C O. And thus have you upon your Table an exact Plot of your Mannor with great eaſe and celerity.

There is yet another way to perform this Work. When you have taken the true Plot of the outward bounds or Periphery of the whole Mannor upon a ſheet or more of Paper, if you will take the pains to go over every particular Incloſure again, and draw particular Plots of every parcel by the ſame Scale wherewith you laid down the Plot of the Periphery; then over the Plot of every particular Incloſure draw parallel Meridians: And when you have thus plotted every particular, if you cut them off by their bounders, and lay them one by another according to their Situation within the Plot of the whole Periphery, you ſhall find that thoſe Plots (if your work be true) will juſtly fill the Plot of the whole, leaving no vacuity.

II. *By the* Theodolite *or* Circumferentor.

Fig. XIII. BY what hath been hitherto delivered concerning the Harmony between the *Theodolite* and *Circumferentor*, you may perceive that the working by any one of them being rightly underſtood, the application thereof to any of the other will be apprehended at the firſt ſight: I will therefore inſtance in the *Circumferentor*, as being moſt general. Let the Example of the laſt *Chapter* ſerve, where the Figure A L M N P Q S T V X G H K repreſented part of a Mannor. Then having provided your Field-book ready Ruled, you muſt at the head of one of the leaves thereof write the Title of the Mannor, the County in which it is, and who is Lord thereof, As,

The Mannor of Elſmore, *in the County of* S. *for the Honourable* R. B. *Lord thereof.*

THen beginning with your firſt Cloſe, write over the head of your Field-book the Tenant's name, the name of the Cloſe, and the tenure by which he holds the ſame. So for the firſt Cloſe,

Henry Grey, Coshye Cloſe, Paſture, Free.

Under this draw a Line quite through your Book; then beginning to Survey this Cloſe, place your Inſtrument at A, and direct your Sights to L, noting the degrees there cut, which let be 160 degrees 45 minutes; which 160 degrees 45 minutes muſt be noted in the firſt and ſecond Columns of the Field-book: Then meaſure the diſtance A L 8 Chains 68 Links, which place in the third and fourth Columns.

2. Remove your Inſtrument to L, and direct the Sights to M, the Needle cutting 181 degrees 30 minutes, and the line L M containing 6 Chains 55 Links, which note down in your Field-book.

3. Place your Inſtrument at M, and direct the Sights to N, the Needle cutting 233 degrees, and the line M N 7 Chains 27 Links, which note in your Field-book. And in regard you are to leave the Hedge or bounder A L M N, adjoyning to *Wisby Common*, (which appertaineth to another Mannor, and therefore only the name inſerted for your remembance when you come to protraction,) you muſt draw a line quite through your Field-book, and in the laſt Column thereof write *Wisby Common*, which denotes unto you that you are to leave the bounder of *Wisby Common*.

4. Place your Inſtrument at N, and direct the Sights to O, the Needle cutting 355 degrees 40 minutes, and the diſtance N O being 4 Chains 45 Links, which note in your Field book as before.

5. Place your Inſtrument at O, and direct the Sights to C, the Needle cutting 309 degrees 30 minutes, and the line O C containing 6 Chains 64 Links, which note in your Field-book.

Now becauſe at theſe two Obſervations you went againſt the Hedge or bounder of *Banton Plain*, you muſt againſt them write in your Field book *Banton Plain*; and becauſe you are now to leave the Hedge or bounder of *Banton Plain*, draw a line quite through your Field-book.

6. Place you Inſtrument at C, and direct the Sights to B, the Needle cutting 54 degrees 00 minutes, and the diſtance C B being 8 Chains 5 Links: The degrees and minutes muſt be noted in the firſt and ſecond Columns of your Field-book, and the Chains and Links in the third and fourth.

7 Re-

7. Remove your Inſtrument to B, and direct the Sights to A, the Needle cutting 19 degrees 30 minutes, and the Diſtance B A being 6 Chains 43 Links: The degrees and minutes muſt be noted in the firſt and ſecond Columns of your Field-book, and the Chains and Links in the third and fourth. Now becauſe at theſe two laſt Obſervations you went againſt the Hedge or bounder of *Bay Wood*, you muſt therefore againſt them write *Bay Wood*; and becauſe you have now finiſhed your firſt Cloſe, you muſt draw a double Line through your Book for your Remembrance.

Then conſider which parcel is next fitteſt to be taken in hand, which let be *Bay Wood*; and withal at what angle thereof it is moſt meet to begin, which ſuppoſe C; and here (for your help when you come to protraction) you muſt expreſs in the title of this ſecond Cloſe at what Angle you begin the ſame, (unleſs you had begun it where you ended the laſt at A, and then it is not material:) Wherefore ſeeing you are beſt to begin at C, look in your Field-book (on the work of the laſt Cloſe) what degrees and minutes the Needle cut at C, which were 54 degrees and 8 Chains 5 Links, therefore againſt that number make this ⊙ or the like Mark, and write the Title for your ſecond Cloſe thus:

Samuel White, *Bay Wood*, by Leaſe,
begin at ⊙.

By this means you ſhall readily know, when you come to protraction, where to begin with this parcel, and in the margin place (2) for the number of your ſecond parcel; and then proceed in your work of Surveying this parcel as before you did for the other, 'till you have gone round about the ſame, ending at A where you firſt began, noting down all your Obſervations both of lines and angles, with the particular bounders as you go along in your Field-book, in all reſpects as you did thoſe of the firſt Cloſe: And in thus doing you ſhall find that at your firſt Obſervation from C to E, you went partly by the Hedge or Bounder of *Banton Plain*, and partly by the Hedge or Bounder of *Church-Field*; and therefore againſt the degrees of that Obſervation, write *Banton Plain* & *Church-Field*, there drawing a line: Then at your two next Obſervations at E and F, you went along the Hedge or Bounder

The Mannor of Elſmore *in the County of S. for the Honourable* R. B. *Lord thereof.*

(1) *Henry Grey*, *Cosby Cloſe*, Paſture, Free.

160	45	8	68	*Wisby Common.*
181	30	6	55	
233	00	7	27	
355	40	4	45	× *Banton Plain.*
309	30	6	64	
54	00	8	5	⊙ *Bay Wood.*
19	30	6	43	

Bounder of *Church-Field*; and at the three last Observations at G H and K, you went against the Hedge or Bounder of *Wisby Common*, there finishing your second parcel: Wherefore draw a double line quite thro' your Field-Book.

These two parcels being finished, consider which is next fittest to be taken in hand, and where to begin it; which suppose *Banton Plain*, and to begin at N: Wherefore look in your Field-Book what degrees the Needle cut when you made Observation at the end in the Surveying of *Cosby Close*, and left the Bounder of *Wisby Common*, which degrees you shall find to be 355 degrees 40 minutes, and 4 Chains 45 Links; therefore at the end of that line where you find 355 degrees 40 minutes, and 4 Chains 45 Links, make this ✕ or some other mark for a remembrance when you come to Protraction. Then for the next parcel write in your Field-Book,

(2) *Samuel White*, *Bay Wood*, by Leale, begin at ⊙.

220	00	9	22	*Banton Plain*, and *Church-Field*
15	0	5	50	*Church Field.*
327	45	5	68	
87	30	6	84	*Wisby Common.*
113	30	6	73	
153	30	6	69	

(3) *George Burton*, *Banton Plain*, for two Lives, begin at ✕.

220	20	9	32	*Wisby Common.*
249	30	10	50	*The Forrest.*
15	40	10	75	✕
52	30	5	3	*Church Field.*

(4) *Thomas King*, *Church-Field*, by Leale, begin at ✕.

316	20	13	12	*The Forrest.*
17	15	10	83	*Church-lane.*
56	00	6	15	*Odcumb Close.*
24	10	6	18	

(5) *John Nichols*, *Odcumb Close*, Free, begin at—

334	30	7	3	*Church Lane.*
48	30	6	25	
101	30	6	18	

George Burton, *Banton Plain*, for two Lives, begin at ✕.

This being done, place your Instrument at N, and direct the sights to P, the Needle cutting 220 degrees 20 minutes, and the line N P containing 9 Chains 22 Links, which note in your Field-Book: And because at this Observation you went by the Hedge or Bounder of *Wisby Common*, and are now to leave it; therefore draw a line, and write *Wisby Common*: And in this manner must you go about this parcel also, 'till you come to close at D, and having finished draw a double line.

Then

Then considering that *Church-field* is next fittest to be Surveyed, and that it is most convenient to begin the same at Q, therefore look what degrees the Needle cut at Q in the Surveying of *Banton Plain*, which were 15 degrees 40 minutes, and 10 Chains 75 Links; against which in your Field-book, make this ⨉ or the like Mark for your remembrance: And for your next Close write in your Field-book as followeth:

Thomas King, *Church-field*, by Lease,
begin at ⨉.

Then placing your Instrument at Q, direct the sights to S, noting the degrees cut, and the length of every line measured, with your particular Bounders, as you did in the other Closes before, 'till you come to inclose at G: And when you have done, draw a double line quite through your Field-Book, and write the title of the next Close to be Surveyed in this manner;

John Nichols. Odcumb Close, Free,
begin at——

Then placing your Instrument at T, direct the sights to Y, and note the degrees cut and the lines measured as in those before, 'till you have gone round the Field to G. And thus, if there were never so many Inclosures, you may (without confusion) easily distinguish the work of the one from the other, and be able (remembring the premisses) to draw a Plot thereof at any time; remembring always, that those numbers in the margent of your Book ought to be placed severally in your Plot in those Closes they represent.

These Instructions given being sufficient for the application and use of the Field-Book, I shall desire every Practioner to make frequent Trial and Practice thereof, and compare the Book with the Plot; and protracting the same according to the directions hereafter given, you will find it to be most exact and facile.

Here by the way I might give directions whereby to take in divers Severals at once, if the Bounders be regular, which will much ease you both in Surveying and Protracting: But by small practice this and divers other Abbreviations will appear of themselves.

I have here added one leaf of your Field-Book as it ought to be Ruled, which take for an Example, it being the Collections of the work of this Chapter, with the several Lines, Angles and Bounders, as you observed them in your Survey.

CHAP. XXIV.

How to protract or draw the Plot of a whole Manor, or of divers Inclosures, the Observations of the several Angles, Lines and Bounders being noted in your Field-book.

Fig. XIV. PRovide a Skin of Vellum, or Parchment, or divers Sheets of Paper neatly fastned together with mouth-glue according to the magnitude or greatness you intend to have your Plot: Which Paper or Parchment let be ruled all over with occult parallel Lines, representing Meridians, as is taught in the 36. Chapter of this Book: The distance of which Lines one from another must not exceed the breadth of the Scale of your Protractor.

Now suppose you were to protract the Observations of the last Chapter, laying your Field-Book before you, consider which way your Plot will extend, and accordingly begin your Work, as at the point A; upon which point A place the Center of your Protractor, turning it about, 'till the correspondent divisions at each end of the Scale of the Protractor lie directly upon one of the parallel Meridians; and staying the Protractor there, look in your Field-book what deg. and minutes the Needle cut at your first Observation at A, which were 160 degrees 45 minutes; therefore against 160 degrees 45 minutes of your Protractor make a mark, and through that mark and the point A draw the Line AL, containing 8 Chains 68 Links.

Then place the Center of the Protractor upon the point L, in all respects as before; and finding your next degrees and length to be 181 degrees 30 minutes, and the length 6 Chains 55 Links, therefore against 181 degrees 30 minutes of your Protractor make a mark, and through it draw the Line LM, containing 6 Chains 55 Links.

Then place the Center of the Protractor upon the point M, and look in your Field-book what degrees were cut at M, protract those degrees, (as before) and draw the line MN, containing 7 Chains 25 Links.

Then place the Center of the Protractor upon the point N, the degrees cut being 355 degrees 40 minutes, the line NO containing 4 Chains 45 Links; and because against these 355 degrees 40 minutes you find in your Field-book this mark ✕ there placed, you must therefore (with Black lead or the like) make the same mark at the point N upon your Paper, to signifie that you must there begin to protract some other Close.

In this manner must you proceed with all the other Lines and Angles, as you find them noted in your Field-book, 'till you have gone over your first Close, and closed your Plot at A.

Having thus finished your first Inclosure, you must deal in the same manner with the second, third and fourth, and so on, were there

there never ſo many. And to know where to begin to protract your ſecond Incloſure, you muſt have recourſe to your Field-book, where you ſhall find this mark ⊙, at which you muſt begin your ſecond Incloſure, which is *Bay Wood*, and the like mark upon your Paper at the point C, which is your remembrancer to put you in mind that at the point C you muſt begin to protract your ſecond Incloſure, as you did your firſt Cloſe.

¶ In this manner of protracting there is no difference nor cautions to be obſerved, more then thoſe already hinted. If the degrees to be protracted be under 180, to lay the Semicircle of the Protractor upwards or from you; and if they be above 180, to lay the Semicircle downwards.

CHAP. XXV.

By way of Concluſion *to this Fourth Book, and clearing of ſome doubts that may ariſe therein.*

WHereas throughout this *Book* almoſt in every *Chapter* you meet with theſe or the like words, *Place your Inſtruments at the Angle* A, *or* B, *&c.* it is not there ſuppoſed you ſhould ſet your Inſtrument in the very angular point, for that is impoſſible to be done but at ſome competent diſtance from it, for *Banks*, *Buſhes*, *Trees*, or the like Obſtacles (almoſt in every Field) will prevent you. You muſt therefore ſet your Inſtrument as near as conveniently you can, and meaſure from your Inſtrument to thoſe ſmall returns which you ſhall find almoſt at every eminent turning. Neither when I ſay, *Meaſure the length of the Line* AB *or* CD, do I mean that you ſhould go on the top of the Bank among the Buſhes, or in the Ditch, but at a competent diſtance from all theſe Obſtacles: but yet you ought to meaſure parallel to the Hedge or Bank, and give it its due Length. And whereas in other places I ſay, *Place your Inſtrument at every Angle*, I do not by thoſe words mean at every ſmall bowing, which returns again to a ſtraight Line ſuddenly, or at every ſmall Crook of a River or Rill; but I mean at every grand or eminent Angle, that varies the Coaſt 3, 4, or 5 Points of the Compaſs, and ſo goes on for a conſiderable Length together: for the fewer times you remove your Inſtrument, the more exactly ſhall you perform your Work. For I have Surveyed a Field that hath had above 20 ſides and as many Angles in it, and yet placed my Inſtrument but in 3 Places in going round about the Field; and in my meaſuring from Station to Station I have taken in all my ſmaller Angles and Out-lets, with Gates, Stiles, Trees ſtanding alone, and the like. For thoſe ways taught of Meaſuring of Fields at *One*, *Two*,

or *Three* Stations taken in the Middle thereof, or at any one Angle, will in the Survey of very large Enclosures ſtand you in as much ſtead as in Meaſuring of ſmall Grounds: and what Inſtrument ſoever you uſe, the Reaſon is the ſame in all, although the manner of Work do differ.

In caſting up the Content of Plots when they are taken, I ſay, *You muſt divide your Field into Trapezias and Triangles.* It is true, ſo you muſt: but when you have a large thing plotted, and you are to give the Content thereof in Groſs, then draw the greateſt *Trapezia* that poſſibly you can in the Middle of the Plot, and then you will have only the ſmall Out-lets to meaſure by Triangles, which being but ſmall can make little or no variation or difference in your Content. But the principal care will be to meaſure the Diagonal and Perpendiculars of the middle large *Trapezia*; for miſſing in taking of the Lengths of either of them will occaſion a great Errour, and therefore it ought to be very circumſpectly performed.

'I have in this place given a ſlight Caution concerning theſe 'Matters; but you will find ways following in this Book, whereby they will be all eaſily prevented.

The End of the firſt Part of the Fourth Book.

THE

THE FOURTH BOOK.

The Second Part.

CHAP. I.

How to find how many Acres, Roods, *and* Perches, *are contained in any piece of Land, the Plot thereof being first taken by any Instrument.*

HAving shewn how to take the Plot of any Field or other Inclosure several ways, and also to Protract the same upon Paper, it is now necessary to shew how the Content thereof may be attained, that is to say, how many *Acres*, *Roods*, and *Perches*, any Field so Plotted doth contain. In the performance hereof you must consider, that the Original of the mensuration of all superficial Figures, such as *Land*, *Board*, *Glass*, or the like, doth depend upon the exact measuring of certain regular Figures, as the *Geometrical Square*, the *Long Square* or *Parallelogram*, the *Triangle*, the *Trapezia*, and the *Circle*: Therefore, if any Plot of Land to be measured be not one of these Figures, it must (before it can be measured) be reduced into some of these Forms. I will therefore, in the first place, shew how to measure any of these Figures severally by themselves; and afterwards, how to reduce any other irregular Figure into some of these regular Forms; and lastly, to measure them by the same Rules. And first,

I. *Of the Geometrical Square.*

A *Geometrical Square* is a Figure conſiſting of four equal ſides, and as many equal Angles; as is the Square ABCD, (*Fig.* 25.) whoſe ſides are all equal, which containeth ſix equal parts, which may be attributed either to *Inches*, *Feet*, *Yards*, *Perches*, *Chains*, or any other meaſure whatſoever.

Now to find the ſuperficial content of ſuch a Square you muſt multiply one of the ſides in it ſelf, and the product of that multiplication ſhall be the Content of the Square.

EXAMPLE.

Suppoſe the Square ABCD, (*Fig.* 25.) to be a piece of Land, and the ſide thereof to contain 6 Perches, therefore multiply 6 in it ſelf, that is, multiply 6 by 6, and the produſt will be 36; and ſo many Perches doth the Square piece of Land contain.

And here obſerve, that if the linear Meaſure had been Feet, the Content had been ſuperficial Feet; or if the Length had been taken in Yards, the Content had been ſuperficial Yards, *&c.*

II. *Of the Long Square or Parallelogram.*

A *Long Square* or *Parallelogram*, is a Figure conſiſting of four ſides, as ABCD, (*Fig.* 26.) the two oppoſite ſides whereof are equal, as the ſides AB and CD, and likewiſe AC and BD; each of the ſhorter ſides containing 7 Perches, and the longer ſides 13 Perches.

To find the ſuperficial content of this *Long Square* or *Parallelogram*, you muſt multiply one of the longer ſides by one of the ſhorter, that is, multiply 7 by 13, and the product will ſhew the ſuperficial Content thereof.

Example. The longer ſide of the Square contains 13 Perches, and the ſhorter 7 Perches; now if you multiply 13 by 7, the product will be 91, and that is the Content of the Square in Perches. If the Numbers 13 and 7 had repreſented linear Feet, the Product 91 had been Superficial Feet.

There are two other 4 ſided Figures, which may be ſaid to have ſome regularity, and often fall out in Buildings, *viz*, a Parallelogram (as ABCD, ſee *Fig.* 27.) having its oppoſite ſides both ways parallel, or ſuch a Figure as hath only two ſides parallel as GHIK, (ſee *Fig.* 28.) For the firſt multiply one of the ſides AB by AE the Perpendicular diſtance of AB from its oppoſite CD (produced if need require it) and the Product is the Content. That is,

	Feet.
AB	9
AE	11
	99 the Content.

For

For the latter Figure, multiply half the ſum of the parallel ſides GH and KI by their diſtance LM, and you have the Content, that is,

	Feet.
KI	14
GH	10
½ of	24
is	12
LM	7
	84 the Content.

1. Half the length of the Baſe, being multiplied by the length of the Perpendicular, ſhall be equal to the *Area* of the Triangle.

Or, 2. Half the length of the Perpendicular, being multiplied by the whole Baſe, will be the content of the Triangle.

Again, 3. The whole length of the Perpendicular, being multiplied by the whole length of the Baſe, half the product ſhall be the Content of the Triangle.

EXAMPLE.

Suppoſe you were to find the *Area* or content of the Triangle ABF (*Fig.* 29.) the Baſe thereof AF containing 58 Perches, and the Perpendicular BE 24 Perches.

Now if you multiply 12 (which is half the length of the Perpendicular BE) by 58 (the length of the whole Baſe AF) the product will be 696; and that is the *Area*, or the content of the Triangle.

Or, if you multiply 24 (the whole length of the Perpendicular) by 29 (the length of half the Baſe,) the product will be 696 as before.

Or again, if you multiply 58 (the whole length of the Baſe) by 24 (the whole length of the Perpendicular,) the product will 1392, the half whereof is 696, the *Area* or content of the Triangle as before. And of theſe three Methods, the fitteſt for Surveying is this laſt, the other two for Building.

And here Note, That though the Perpendicular BE had fallen without the Triangle on the Baſe produced (as in *Fig.* 31;) yet ſtill the Product made by multiplying the whole length of the Baſe AF by the Perpendicular, had been double the content of the Triangle, as before; and all the three preceeding Rules would hold good.

Laſtly, if through the middle of the Perpendicular or Sides, in either Example, be drawn a line parallel to the Baſe, as GH; then GH (in the firſt Example) 26 ½ multiplied by the Perpendicular, gives the content. And this is common in meaſuring Buildings.

IV. *Of the Trapezia.*

A *Trapezia* is a Figure consisting of four unequal sides, and as many unequal angles, as is A B C D, *Fig.* 30.

To measure this *Trapezia*, you ~~must~~ first draw the Diagonal line B D, for by this means the Figure is reduced into two Triangles, as A D B, and C D B: Then if you let fall the Perpendiculars from the points A and C, you may measure them by the last Example as two Triangles, the sums whereof being added together will be the *Area* or content of the whole *Trapezia.*

EXAMPLE.

Having drawn the line B D, and so reduced the *Trapezia* into two Triangles, and let fall the Perpendiculars A E and C F upon the line B D, which is the common Base to both the Triangles, you may find the *Area* of the whole *Trapezia*, thus:

Suppose the Perpendicular C F, were 102 Perches, the Perpendicular A E, 118 Perches, and the Base B D, (which is common to both Triangles) 300 Perches.

Now if according to former directions, you multiply 300, the Base, by 59, half the Perpendicular A E, the product will be 17700, for the content of the Triangle A B D.

In like manner, if you multiply 300, the Base, by 51, half the Perpendicular F C, the product will be 15300, for the content of the Triangle B C D.

Now if you add the contents of these two Triangles together, namely, 17700 and 15300, the sum of them will be 33000; and that is the content of the whole *Trapezia* A B C D.

But this Work may be performed with more Brevity, for there are as many varieties of measuring of *Trapezia*'s, as there were of Triangles, namely three.

In respect the Base B D is common to both the Triangles, you may therefore add the two Perpendiculars together; the half of which being multiplied by the whole Base, the product will shew the content of the whole *Trapezia.*

EXAMPLE.

The two Perpendiculars, 118 and 102, being added together, the sum of them is 220, the half whereof is 110; this number being multiplied by 300 (the whole length of the common Base) giveth 33000, the content of the whole *Trapezia.* Or,

2. You may multipply 220, the sum of the Perpendiculars, by 150, half the length of the Base, and the Product will be 33000, as before. Or,

3. You

3. You may multiply the ſum of the Perpendiculars, 220, by the Baſe, 300, and that product will be 66000; the half whereof is 33000, as before. And this laſt Method is fitteſt for a Surveyor.

And theſe Rules are alſo true, though one or both of the Perpendilars ſhould fall without (as in *Fig.* 31;) for then the ſum of the Perpendiculars B E and C D, multiplied by the Diagonal A F, produces the double content.

V. *Of* Irregular Figures, *how to reduce them into* Triangles *or* Trapezia's, *and to caſt up the Content thereof.*

LEt A B C D E F G H (*Fig.* 32.) be the Figure of a Field drawn upon your Plain Table, or otherwiſe protracted upon Paper, according to any of the former directions.

In regard that the Field is irregular, that is to ſay, it is neither *Square*, *Triangle*, or *Trapezia*, it muſt therefore (before it can be meaſured) be reduced into ſome of theſe forms; which to effect do thus: Draw lines from one angle to another, as the lines A D, D B, A F, and F H; then will the whole Figure be reduced into ſix Triangles, as

1. The Triangle B C D,
2. The Triangle A D B,
3. The Triangle A D E,
4. The Triangle A E F,
5. The Triangle A F H,
6. The Triangle F G H.

Theſe ſix Triangles being meaſured ſeverally, according to the former directions, and the contents of them all added together into one Sum, will ſhew the *Area* or content of the whole Field. As,

Suppoſe the Triangle	B C D	ſhould contain	72
	A D B		84
	A D E		110
	A E F		121
	A F H		165
	F G H		66
		The Sum	618.

Perches.

Theſe ſix Numbers being added together make 618 Perches; and that is the *Area* or content of the whole Field in Perches.

But for an abbreviation of this Work, you need not to find the *Area* of every *Triangle*, but of every *Trapezia*, as is before taught; for the Figure is as well divided into *Trapezia's* as *Triangles*, namely, into the *Trapezia's* A B C D, A D E F, A F G H.

By this means you need but to find the *Area* or content of theſe three *Trepezia's*, which will abbreviate nigh half of the Arithmetical

cal Work: For if you measure the three *Trapezia's* severally, as hath been taught in this Chapter, you shall find

the *Trapezia* { A B C D / A D E F / A F G H } to contain { 156 / 231 / 231 } Perches.

The Sum 618.

These three Numbers being added together produce 618, exactly agreeing with the former.

Or rather thus, add the double content of all the *Trapezia* and Triangles together, and then half the sum will be the content sought, *e. g.* (See *Fig.* 33.)

Perpend. { B H— 9 / K D— 6 } — 15

Diagonal A C 23 — 45 — 30

double Content 345

Perpend.— 9 D N
Base, ——10 F E

double Content 90

Perpend. { L D 10 / G M 7 } — 17

Diagonal A F 19 — 153 — 17

double Content 323

345 / 90 / 323 } double Content.

the $\frac{1}{2}$ of 758 double the Content of the whole.
is 379 the true Content.

Or the Contents of any Field may be readily cast up thus: Take every Base and every Perpendicular of every Triangle, and every Diagonal of every *Trapezia*, in Links, esteeming every Chain one 100; in every *Trapezia*, multiply the sum of the Perpendiculars by the Diagonal; and in every single Triangle, the base by the Perpendicular; then add the several Products together: Then from the right hand make a Dash between the fourth and fifth places, and another between the fifth and sixth; then halve the Figures to the left hand of the Dashes, and so will this half be Acres. If an Unite remain, that Unite is an half Acre or two Roods; and if the Figure between the Dashes be five or more, take five from it, and account it

it another Rood: Laſtly, Multiply the remaining Figure between the Daſhes by 8, and to product, add the Tens to be carried from the fourth Figure, and you have the Perches. If any Perſon is is ſo curious, as to eſteem the Decimal parts of the Perches, they will be the Product made by multiplying the Figures to the Right-hand of the Daſh by 8. So in Figure 36 the Operation will be thus.

313 = AC
612 = DE
925
725 = BF
4625
1850
6475
670625

214 = KL
396 = HI
610
500 = FM
305000

FG = 418
AH = 900
376200

670625
305000
376200
13|5|1825
A. R. P.
Anſwer, 6 . 3 . 1

Here half 13 gives 6 the Acres, and one remaining is 2 Roods; then the 5 between the Daſhes gives another Rood; and ſo the whole is 6 Acres and 3 Roods; and becauſe there is but one Ten to be carryed from the fourth place, and that after the 5 is taken out of the fifth, there remains nothing, there is but one Perch.

In like Manner if the whole Sum of all the

Products be	the Content is A. R. P.
17|4|5364	8 . 2 . 36
11|9|2765	5 . 3 . 34
10|5|4321	5 . 1 . 03
8|4|3764	4 . 0 . 35

So if the ſum of the Products be 41|7|6354. the Content is A. R. P.
20 . 3 . 21|0832. But this Method muſt be only uſed when the Figure is reduced to Triangles and Trapezias.

2. *To find the* Area *or Superficial Content of a Circle.*

TO find the *Area* or Content of any Circle, you muſt multiply the Diameter thereof in it ſelf, and multiply that Sum by 11, which Product being divided by 14, ſhall give you the *Area* of the Circle.

EXAMPLE.

In this Circle ABCD, (*Fig.* 34.) let the Diameter thereof DB be 28, which multiplied in it self giveth 784, this number multiplied by 11 giveth 8624, which being divided by 14, the Quotient will be 616; and that is the *Area* of the Circle.

Or thus: Half the Diameter multiplied by it self, and the Product again by 3 and $\frac{1}{7}$ gives the Content.

Thus $\frac{1}{2}$ the Diameter 14

14

56

14

196

3 $\frac{1}{7}$

588

28

616 the Content.

Or thus: From the Product made by multiplying the Circumference by it self substracted $\frac{1}{11}$ part of the Product, and divide the Remainder by 11.

The Circumference 88

88

704

704

8) 7744

968

11)6776

The Content 616

3. *To find the* Area *or Content of a Semicircle, Quadrant, or other Sector of a Circle.*

ALL these Portions of Circles are measured by this one general Rule, *viz.*

Half the length of the Arch-Line, being multiplied by the *Radius*, or half the Diameter, shall give the content of that Semicircle, Quadrant, or Sector.

EXAM.

1 EXAMPLE.

For the Semicircle ABC (*Fig.* 34.) half the Arch-Line thereof is 22, and half the Diameter OC or OA is 14, which multplied together make 308 for the content of the Semicircle ABC.

2 EXAMPLE.

For the Quadrant OAB, the half Arch-Line AB is 11, which multiplied by 14, the Semidiameter OA, giveth 154 for the *Area* of the Quadrant OAB.

3 EXAMPLE.

For the Sector OBE, whose Arch-Line is 8, the half thereof is 4, which multiplied in the Semidiameter OC or OE, 14, giveth 56 for the *Area* or content of the Sector OBE.

Again, for the other Sector OEC, whose Arch-Line is 14, the content thereof will be found to be 98, which with the other Sector 56 make 154, equal to the whole Quadrant.

The length of the Arch may be found thus; Let GH bisect AE perpendicularly and draw GA. Then from 8 times AG take AE, and divide the Remainder by 3, and you will have the length of the Arch AGE very near.

4. *To find the* Area *of a Segment of a Circle.*

THIS Problem is something difficult to perform exactly, however I will give you a Rule whereby you shall come very near the truth.

Example. Let it be required to find the Content or *Area* of the Segment AEG. First draw the Chord-Line AE, and measure the length thereof, which suppose to be $25\frac{1}{2}$; then measure the Perpendicular GH, which suppose to be 7. Now I say, if you multiply the Perpendicular 7 by two thirds parts of the Chord-Line AGE, you shall have the near *Area* of the Segment AGE.

Example. Two third parts of 25 and a half is 17, which multiplied by 7, the Perpendicular GH, produceth 119, which is the near *Area* of the Segment: Which we will thus prove.

First, the *Area* of the whole Sector AOE may be found as before is taught: For the Arch-Line AB being a Quadrant is 22, and the Arch-Line BE is 8, which together make 30, the half whereof, 15, multiplied by the Semidiameter OB, 14, giveth 210, for the *Area* of the whole Sector AOE. Now the whole Sector, which contains 210, consisteth of these two parts, namely, the Segment AGE, and the Triangle AOE: wherefore find the *Area* of the Triangle AOE, the Base AE is 25 and a half, the Perpendicular 7; (it being the remainder of GH taken from

OG

OG 14;) wherefore multiply 25 and a half by 3 and a half, and the Product will be 90 and a quarter, for the *Area* of the Triangle. Now it follows,

The whole *Area* of the Sector OAE is —— 210

The *Area* of the Segment AGE is —— 119
The *Area* of the Triangle AOE is —— 90¼

The Sum—209¼

Which is equal to the whole Sector, within less than an Unit.

Or easier thus, draw AG; then to ⅓ of AG add AH; and multiply the Sum by ⅘ AD. Or nearer thus; Find I the middle of GH and draw AI; then add AG to 4 times AI and ⅓ of the Sum multiplied by ⅘ AD gives the Content of the Segment (tho' it be almost as great as the Semicircle it self) as near, as the Proportion of *Archimedes* gives the whole Circle.

When AE (*Fig.* 35.) is assigned for the length of an Ellipse and, FG for its breadth; make FB and FD equal to AC or CE; then is the Length AE called the Tranverse Diameter, FG its Conjugative Diameter, C the Center, B and D the Foci.

To find the Periphery of the Ellipse, add once and ⅐, the conjugative Diameter, to twice the Tranverse, and the Sum is the Periphery nearly.

Or nearer thus, draw FA; and then to FA add its 9th part, and the Sum multiplied by 4, gives the thing required.

Or (for the sake of the Curious) make, as the fourth power of AF, to the fourth Power of BC, so AG to a fourth proportional, which taken from 10 times DC, and the Remainder multiplied by 4, gives a Product, which divided by 9, is the Periphery of the Ellipse, as near as the Periphery of the Circle is given by *Archimedes*.

But if the Diameter of a Circle had been given to find the Circumference, the Work had been thus, To thrice the Diameter, add ⅐ of the Diameter. Let 28 be the Diameter, and then

28
3

thrice the Diameter —— 84
⅐ part of the Diameter — 4

88 gives the Circumference.

Or as 113 to 355, so the Diameter to the Circumference.
Or as 1 to 3,14159, so the Diameter to the Circumference.

CHAP.

CHAP. II.

Of the manner of caſting up the content of any piece of Land in Acres, Roods and Perches.

IN the Fifth *Chapter* of the Second *Book* you have a deſcription of Chains in general, and more particularly of Mr. *Rathborn*'s and Mr. *Gunter*'s. In the meaſuring of Land by Maſter *Rathborn*'s Chain, you call every Pole or Perch thereof (which is divided into 100 Links) an *Unite*, and every ten of thoſe Links you call a *Prime*, and every ſingle Link you call a *Second*.

Now becauſe there are divers that fancy this Chain rather then any other, becauſe it giveth the content of any Superficies meaſured therewith in its ſmalleſt denomination, namely, in Perches and parts of a Perch, ſo that when any Superficies is caſt up and brought to Perches, it may eaſily be reduced into Roods and Acres; therefore (for their ſakes that affect this Chain) I will ſhew the Uſe thereof, and afterwards of Maſter *Gunter*'s Chain, leaving every man to take his choice, and uſe that which liketh him beſt.

Suppoſe that ABCD (*Fig.* 24.) were a piece of Land lying in a long ſquare, which being meaſured by Mr. *Rathborn*'s Chain ſhould contain in length 16 *Unites*, 2 *Primes*, and in breadth 1 *Unite*, 3 *Primes*, 2 *Seconds*, and that it were required to find the *Area* or content thereof in Perches; to effect this, you muſt multiply the length by the breadth, as is taught in the laſt Chapter; therefore, the length being 16 *Unites*, 2 *Primes*, and the breadth 1 *Unite*, 3 *Primes*, 2 *Seconds*, theſe two numbers multiplied together ſhall produce the *Area*.

Set your numbers down as you are taught in the 5 *Chapter* of the 2 *Book*, or as you ſee them ſtand in this *Example*, with a prick over the head of every fraction: Under theſe numbers draw a line, and multiply them together in all reſpects as if they were whole numbers; and then the work will ſtand thus, the product of your multiplication being 21384. Now becauſe in your two numbers, *viz.* your multiplicand and your multiplier, there are three fractions, namely, one in your multiplicand, and two in your multiplier, you muſt therefore (with a daſh of your Pen) cut of the three laſt figures of the Product towards your Right-hand, and then will your Product ſtand thus; the three laſt Figures whereof are the Numerator of a Fraction, whoſe Denominator is 1000, and the other two Figures toward your Left-hand are Integers of your multiplication: ſo that the ſum of this multiplication is 21 Perches, $\frac{384}{1000}$ parts of a Perch, which is ſomething more than a third part of a Perch.

:
162
..
132
324
486
162
21384
21|384

But to expreſs the exact quantity of theſe Fractions in a buſineſs of this nature were ſuperfluous; only obſerve this one Rule for all, namely, that if the Figures cut off come near to a Unite, that is, when the Figures cut off are near as much as thoſe underneath them, or the firſt Figure cut off is either 7, 8, or 9, you may then increaſe your whole number by a Unite, and not at all regard the Fraction.

But for your farther practice take another Example, which let be a piece of Land containing in breadth 5 *Units*, 6 *Primes*, 3 *Seconds*, and in length 15 *Unites*, 4 *Primes*, and 2 *Seconds*; which place as before.

1542	Now if you multiply theſe numbers one by another as if they were whole numbers, then will they ſtand as in the margin, the product being 868146; from whence take the 4 laſt Figures, (becauſe there are four fractions in your two numbers,) there remians 86 Perches, and $\frac{8146}{10000}$ parts of a Perch: Now becauſe 8146 is near to 10000, I add 1 to 86, making it 87 Perches, diſregarding the exceſs as immaterial.
563	
4626	
9252	
7710	
86|8146	

In like manner, ſuppoſe the Perpendicular of a Triangle ſhould contain 1 *Unite*, 3 *Primes*, 2 *Seconds*, and half the length of the Baſe ſhould contain 16 *Unites*, 2 *Primes*; theſe numbers being placed as thoſe before, and multiplied one by another, will produce this product 21384: from whence cut off the three laſt Figures, (becauſe there were three fractions in your numbers multiplied, and there will remain 21 Perches, and $\frac{384}{1000}$ parts of a Perch, which being but of ſmall value you may reject.

CHAP. III.

How to reduce any number of Perches into Roods and Acres, or any number of Acres and Roods into Perches.

BY a Statute made the 33. of *Edw.* 1. an Acre of Ground ought to contain 160 ſquare Perches, and every Rood of Land 40 ſquare Perches, and every Perch was to contain 16 foot and a half. Now if any number of Perches be given to be turned into Acres, you muſt divide the number given by 160, (the number of Perches contained in one Acre) and the Quotient ſhall ſhew you how many Acres are contained in that number of Perches; and if any thing remain, (if it be under 40) it is Perches: But if the remainder exceeded 40, then you muſt divide it by 40, (the number of Perches contained in one Rood) and the Quotient ſhall be Roods, and the remainder Perches.

EXAM-

EXAMPLE I.

Let 5267 Perches be given to be reduced into Acres. First divide 5267 by 160, and the Quotient will be 32, and 147 remaining; which divide by 40, and the Quotient will be 3, and 27 remaining: So that 5267 Perches, being reduced into Acres, produce

Acres	Roods	Perches.
32	3	27

Or thus, Divide the Perches by 40, and the Remainder 27 are Perches, and the Quotient 131, divided by 4, leaves 3, which are Roods, and the Quotient 32 are Perches, as before.

EXAMPLE II.

Let 5496 Perches be given to be reduced into Acres, Roods and Perches. *First*, divide 5496 by 160, the Quotient will be 34, and 56 remaining; which 56 being divided by 40, the Quotient will be 1, and 16 remaining: So that the Perches reduced will be

Acres	Roods	Perches
34	1	16

EXAMPLE III.

Let 12169 Perches be given to be reduced into Acres, Roods and Perches, 12169 divided by 160 give in the Quotient 76, and 9 remaining; which 9, being less then 40, is only 9 Perches: So that the Reducement is,

Acres	Roods	Perches
76	0	9

The Arithmetical Work of these Three Examples:

(I)

160) 5267 (32 Acres
480
467
320
40) 147 (3 Roods
120
27 (Perches

(II)

160) 5496 (34 Acres
480
696
640
40) 56 (1 Rood
40
16 (Perches

(III)

160) 12169 (76 Acres
1120
969
960
9 (Perches.

To

To reduce Acres into Perches.

THis is but the converſe of the former: For as (before) to reduce Perches into Acres, you divided by 160, you muſt now, to reduce Acres into Perches, multiply by 160.

EXAMPLE I.

Let 32 Acres, 3 Roods and 27 Perches be given to be reduced into Perches. *Firſt*, multiply the 32 Acres by 160, and the product will be 5120; then multiply the 3 Roods by 40, the product is 120: Theſe two products and the 27 Perches being added together, the ſum will be 5267: And ſo many Perches are contained in the foreſaid number of Acres, Roods and Perches.

```
 5120
  120
   27
 ----
 5267
```

EXAMPLE II.

Let 34 Acres, 1 Rood and 16 Perches be given to be reduced into Perches. *Firſt*, multiply 34 by 160, the product will be 5440; then multiply the 1 Rood by 40, the product will be 40; to which add the 16 Perches, and the product will be 5496: So that in 34 Acrees, 1 Rood and 16 Perches, there are contained 5496 Perches.

```
 5440
   40
   16
 ----
 5496
```

EXAMPLE III.

Let 76 Acres and 9 Perches be given to be reduced into Perches. *Firſt*, multiply 76 by 160, the product will be 12160; to which add the 9 Perches, and the ſum will be 12169: So that in 76 Acres and 9 Perches there are contained 12169 Perches.

```
 12160
     9
 -----
 12169
```

The Arithmetical Work of theſe Three Examples.

(I)	(II)	(III)
32	34	76
160	160	160
1920	2040	4560
32	34	76
5120	5440	12160
40	40	9
3	1	1
120	40	9
27	16	
1	1	
27	16	

Or

Or Acres, Roods and Perches may be reduced to Perches thus: (See *Example* I.) multiply 32 Acres by 4, and to the Product add the Roods 3, and so will the Result be 131 Roods; multiply these by 40, and to the Product add the Perches 27, and the Result 5267 are Perches as required. See the Operation.

A.	*R.*	*P.*
32	3	27
4		
131		
40		
5267		

CHAP. III.

How to cast up the Content of any piece of Land in Acres, Roods and Perches, measured by Mr. Gunter's *Chain.*

IN measuring by Mr. *Gunter*'s Chain, you are in your account only to take notice of Chains and Links, as was before intimated in the Description thereof, *Chap.* 7. *Lib.* 2. Suppose then that ABCD (*Fig.* 26.) were a piece of Land lying in a long Square, and that, being measured by Mr. *Gunter*'s Chain, it should contain in length 9 Chains 50 links, and in breadth 6 Chains 25 links.

Set your numbers down as before is taught, and as in this Example, drawing a line under them: Then multiplying them together, you shall find the Product to be 593750. From which Product you must always cut off the five last Figures towards the right hand with a dash of your Pen; then will the Product stand thus, 5|93750: So is the 5 towards the left hand compleat Acres, and the 93750 hundred thousand parts of an Acre; which 93750 being multiplied by 4, the number of Roods in one Acre, the Product will be 375000. From which Product cutting off five Figure towards the right hand as before, it will stand thus, 3|75000: So is the 3 towards the left hand compleat Roods, and the 75000 hundred thousand parts of a Rood; which being multiplied by 40, the number of Perches in a Rood, the Product will be 3000000; from which cutting off the five last Figures towards the right hand, the Product will stand thus, 30|00000, and the 30 towards the left hand is the number of Perches. And so the *Area* or content of the whole piece will be 5 Acres, 3 Roods, and 30 Perches.

950
625
4750
1900
1700
5|93750
4
3|75000
40
30|00000

Or, the 93750 hundred thousand parts of an Acre may be reduced into Roods and Perches by help of the Table following.

Links.	R.	P.
100000	4	0
90000	3	24
80000	3	8
70000	2	32
60000	2	16
50000	2	0
40000	1	24
30000	1	8
20000	0	32
10000	0	16
9375	0	15
8750	0	14
8125	0	13
7500	0	12
6875	0	11
6250	0	10
5625	0	9
5000	0	8
4375	0	7
3750	0	6
3125	0	5
2500	0	4
1875	0	3
1250	0	2
624	0	1

For if you look for 90000 under the Title *Links*, (which is the first Figure with Cyphers added,) you shall find against it 3 *Roods*, 24 *Perches*; then look for 3750, and against it you shall see 6 *Perches*: All which being added together, as here you see, the *Area* or content of the whole piece will be 5 Acres, 3 Roods, and 30 Perches.

A.	*R.*	*P.*
5	00	00
	3	24
		6
5	03	30

Another *EXAMPLE.*

Suppose the Base of a Triangle should contain 16 Chains 56 Links, and half the Perpendicular of the same Triangle 4 Chains 32 Links, these being multiplied one in the other, will produce the *Area* or content of the whole Triangle.

16,56
4,32

3312
4968
6624

7|15392

Set your numbers down as in the margin is done, and multiply one by the other, so will the Product be 715392: From which cutting of the five last Figures towards the right hand, there will be left before the line of partition 7, which is 7 compleat Acres, and behind the line there will be 15392, which are hundred thousand parts of an Acre; and how much that is, the Table will easily shew. For if you look in the first Column for 10000, against it you shall find 00 Roods, 16 Perches; then looking for 5392, you find it not, but the nearest thereto is 5625, against which there standeth 9 Perches: All these numbers being added together will produce 7 Acres, 00 Roods, 25 Perches, which is the *Area* of the Triangle.

A.	*R.*	*P.*
7	00	00
		16
		9
7	00	25

Thus may you find the *Area* of any Triangle or Parallelogram very easily by one Multiplication and Addition, which is much easier then the way of casting up by Mr. *Rathborn*'s Chain.

By this manner of Work, if the length and breadth of a long Square or Parallelogram given should be 9 Chains 75 Links, and 6 Chains 25 Links, the *Area* of such a long Square would be found to be 6 Acres, 00 Roods, 15 Perches. Or the length and breadth being 12 Chain 42 Links, and 1 Chain 36 Links, the *Area* or content will be found to be 1 Acre, 2 Roods, 30 Perches. Also, the length and breadth being 12 Chains 86 Links, and

5 Chains

5 Chains 25 Links, the *Area* will be found to be 6 Acres, 3 Roods, 00 Perches.

But leſt you ſhould be deſtitute of this Table when you have need thereof, you may have it put upon ſome ſpare place of your Inſtrument; or rather (in ſtead of this Table) a Scale, which I will now ſhew you the Uſe of, which performeth that work far better and more eaſily then the Table, and may conveniently be graduated upon the Index of your Table; the dividing and numbring whereof is well known to the Inſtrument-maker.

The Scale conſiſteth of two parts, one whereof is ſquare Perches, the other ſquare Links. The Scale of ſquare Perches proceedeth gradually from 1 to 40, with ſub-diviſions, and is numbred by 5, 10, 16, 20, *&c.* to 40. The Scale of ſquare Links proceedeth gradually from 1 to 25000, and is alſo ſub-divided, and numbred by 1000, 2000, *&c.* to 25000, equal to 1 Rood or 40 Perches.

The Uſe of the Scale of Reduction.

WE will inſtance in the ſecond Example before going, where the length and breadth of the long Square was 16 Chains 56 Links, and 4 Chains 32 Links; theſe being multiplied together produce 715392, and the five laſt Figures being cut off, there are 7 Acres and 15392 remaining. Now to find how many Roods and Perches this is, look in the Scale of ſquare Links for 15392, and againſt it, in the Scale of ſquare Perches, you ſhall find 24 Perches, and above half a Perch.

Another *EXAMPLE.*

Let us take the firſt Example before going, where the numbers multiplied were 9. 50, and 6. 25; theſe being multiplied one by another produce 59350, and the five laſt Figures being cut off, there will be 5 Acres and 93750 remaining. Now to know how many Roods and Perches are contained therein by the Scale;

¶ You muſt conſider, that 25000 ſquare Links are equal to 1 Rood or 40 Perches, as appeareth by the Scale it ſelf, and and alſo by the Table; then is 50000 equal to 2 Roods, and 75000 equal to 3 Roods: Therefore, if your number remaining exceed 25000, and be under 50000, you may conclude 1 Rood and odd Perches to be contained therein: If it exceed 50000, and be under 75000, you may conclude 2 Roods and ſome odd Perches to be therein: If above 75000, you may then conclude 3 Roods and odd Perches to be therein.

Now in this Example, the number remaining is 93750, which becauſe it exceedeth 75000, I conclude there are 3 Roods contained therein; which I ſet to the 5 Acres, and ſubſtract 75000 from 93750, the remainder being 18750: This number 18750 I ſeek in the Scale of Square

A.	*R.*	*P.*
5	3	30

Links,

Links, and right againſt it I find 30 Perches; which added to the former, giveth 5 Acres, 3 Roods, and 30 Perches, which is the *Area* or content required.

Thus you ſee with what celerity and exactneſs the Scale effecteth your deſires; and therefore let it be graduated upon the Index of your Table, that it may always be ready at hand when you have need thereof. The conſtruction of this reducing Scale I received of my honoured Friend Mr. *S. F.* deceaſed.

CHAP. IV.

How to reduce one kind of meaſure into another, as Statute meaſure to Cuſtomary meaſure, and the contrary.

BY the Precepts delivered in the Second *Part* of the Third *Book*, you may perform this work by the Tables of Logarithms and Lines of Numbers, as is there taught: But however, it will not be amiſs in this place to ſhew how to perform the ſame Arithmetically, that the reaſon thereof may the better appear. Now whereas (by the fore-mentioned Statute) an Acre of ground was to contain 160 ſquare Perches, meaſured by the Pole or Pearch of 16 foot and a half, but in many places of this Nation (through long cuſtom) there have been received other quantities called Cuſtomary, as namely, of 18, 20, 24, and 28 foot to the Pole or Perch: And in ſome place in the *Weſt* of *England*, as about *Dorcheſter*, *Blandford*, &c. they account but 15 Foot and 8 Inches to the Pole, Perch or Roods; it is therefore neceſſary for a Surveyor, to know how readily to reduce Cuſtomary meaſure to Statute meaſure, and the contrary.

Suppoſe then that it were required to reduce 5 Acres, 2 Roods, 20 Perches, meaſured by the 18 foot Pole, into Statute meaſure; you muſt ſeek out the leaſt Numbers in Proportion, as 18 foot to 16 foot and a half, which to perform do thus: Becauſe 16 and a half beareth a Fraction, reduce 16 and a half into halves; and that both your Numbers may be of one Denomination, you muſt reduce 18 (the cuſtomary Pole) into halves alſo; then will your numbers ſtand thus $\frac{3}{3}\frac{3}{2}$: Which abbreviated by 3, by ſaying, How many times 3 in 33? the Quotient will be 11: And again, How many times 3 in 36? the Quotient will be 12. So will the leaſt integer Numbers which are in Proportion, as 46 and a half to 18 be 11 and 12.

This done, reduce your given quantity (5 Acres, 2 Roods, and 20 Perches) into Perches, which makes 900 Perches. Now conſider that what proportion the ſquare of 11, which is 121, bears to the ſquare of 12, which is 144, the ſame proportion doth the Acre of 16 foot and a half to the Perch, bear to the Acre of 18 foot to the Perch.

Now

Now (becauſe the greater meaſure is to be reduced into the leſſer) multiply the given quantity 900 Perches by 144 the greater Square, and the product will be 129600; which divided by 121, the quotient will be 1071 $\frac{9}{121}$ Perches; which being reduced into Acres, giveth 6 Acres, 2 Roods, 31 Perches, and $\frac{9}{121}$ parts of a Perch, according to Statute meaſure.

But on the contrary, ſuppoſe it had been required to reduce Statute meaſure into Cuſtomary meaſure, then you muſt have multiplied 900 Perches (your given quantity) by 121 the leſſer Square, (becauſe the leſſer meaſure is to be reduced into the greater,) and the product will be 108900; which divided by the greater Square 144, the quotient will be 756$\frac{1}{4}$ Perches; which reduced into Acres is 4 Acres, 2 Roods, 36 Perches and a quarter.

The ſame manner of work is to be obſerved in the reducing of any Cuſtomary quantity whatſoever.

And now, before I leave this Chapter, I will inſert a Paper containing a few Examples of this kind. It was lately ſent to me out of *Ireland*, with a deſire to have it inſerted into my Book, which I have accordingly done; it being a moſt excellent and compendious way of performing operations of this nature.

Land was formerly meaſured with a Pole or Perch containing by Statute meaſure feet 16, 5; and 160 of ſuch ſquare Poles or Perches is an Acre of Statute meaſure, which is the uſual meaſure for all ſorts of Land. But it is a cuſtom in ſome parts to meaſure Wood-land with a Perch or Pole of 18 foot long, and to accompt 160 of thoſe Poles or Perches for an Acre of Wood-land meaſure. And in *Ireland* the uſual Perch is feet 21, and 160 of thoſe Perches are accompted to an *Iriſh* Acre. Wherefore

Having the breadth and length of an Oblong Rectangle Superficies given in Perches, to find the Content in Perches,

Multiply (L) the length by (B) the breadth, and the product will be the (C) content in Perches of that meaſure your Pole was; and may be reduced into Acres, Roods and Perches, by dividing the ſame by 40 × 4.

EXAMPLE.

I deſire to know how many Acres, Roods and Perches are contained in Perches 25678.

Firſt, ſet down the Perches given, and then cut off the figure next unto the right hand with a line, as in the Margin; ſo have you divided the number given by 10; Then divided 2567 by 4, the quotient will be 641$\frac{1}{4}$; write 641 before the ſeperating line, and the 3 that was remaining ſet after the ſeparating line, as in the Margin:

40)	2567	8
4)	641	3
	160	1

gin: Then again divide 641 by 4, the quotient will be 160, and 1 remaining; which being ſet down as in the Example in the Margin, you ſhall find 160 Acres, 1 Rood, 38 Perches, to be contained in the number of 25678 Perches, which were propoſed to be reduced. Alſo,

Having the Baſe and Perpendicular of a Triangle given in Perches, to find the Content in Perches.

Multiply the Perpendicular by half the Baſe, or elſe multiply the Baſe by half the Perpendicular, or otherwiſe multiply the Baſe by the Perpendicular, and divide that product by 2, and ſo ſhall you have the content of the Triangle in Perches; which you may reduce into Acres, Roods and Perches, as before taught.

EXAMPLE.

A Triangle whoſe Baſe is Perches 183, and Perpendicular 30, the content will be found 17 *A.* — 0 *R.* — 25 *P.* For,

1 . 30 :: 91, 5 . 2745. Or 1 . 183 :: 15 . 2745.

Otherwiſe, 1 . 183 :: 30 . 5490, which divided by 2, the quotient will be Perches 2745, agreeing with the former.

But becauſe the meaſuring of quantities with ſingle Poles or Perches of ſuch lengths was very tedious, it is now become a cuſtom to uſe a Chain made of ſtrong Wire, whereof thoſe of 4 Pole long, divided into 100 Links, are beſt for eaſe and expedition for Statute Acres; becauſe 1 Chain in breadth, and 10 Chains in length, is a Statute Acre. Wherefore,

If an Oblong Rectangle ſuperficies or Square be meaſured with ſuch a Chain, and the breadth multiplied by the length, and the product divided by 10, the quotient will ſhew the content in Acres and Decimal parts.

EXAMPLE.

An Oblong Rectangle piece of Land being in breadth Chains 8, 2, and in length Chains 16, 75, what is the content in Acres and Decimal parts?

Multiply 16, 75 by 8, 2, the product will be 137, 35; which being divided by 10, (by removing the ſeparating line one place towards the left hand,) the quotient will be Acres 13, 735, the content of that piece propoſed.

But if the Baſe and Perpendicular of a Triangle be meaſured with ſuch a Chain, you may either multiply half the Baſe by the whole Perpendicular, or elſe the whole Baſe by half the Perpendicular, and then

then dividing that product by 10, the quotient will shew the content in Acres and decimals parts. Or otherwise you may multiply the Base and Perpendicular together, and then divide that product by 20, so the quotient will shew what Acres and decimal parts are contained in that Triangle.

EEXAMPLE.

If a Triangle have its Base Chains 16, 75, and its Perpeudicular Chains 8, 2; how much is the content thereof in Acres and decimal parts?

Multiply 8, 375 by 8, 2, or else multiply 16, 75, by 4, 1, and the product will be 68, 675; which divided by 10, the quotient will be Acres 6, 8675.

Or otherwise, 16, 75 being multiplied by 8, 2, the product will be 137, 35; which being divided by 20, the quotient will be Acres 6, 8675, agreeing with the precedent. And hereby it appeareth, that a Triangle is but half a Parallelogram having the same Base and height.

Decimal parts of an Acre are readily reduced into Roods, Perches, and decimal parts of a Perch, by multiplying the decimal parts given by 4 × 4 × 10.

As for Example, let it be bequired to reduce Acres 13, 735 into Acres, Roods, Perches, and decimal parts.

First, set down the number given, as in the Margin; then multiply 735 by 4, the product will be Roods 2,94; then 94 multiplied by 4, the product will be 3,76; which multiply by 10, the product will be Perches 37,6, which sheweth that *Ac.* 13,735 are equal unto 13 *A.*—2 *R.*—37,6 *P.* And contrary,

A.	13,735	× 4
R.	2,94	× 4
P.	37,6	× 10

Roods, Perches, and their decimal parts, are reduced into decimal parts of an Acre, by dividing them by 10 × 4 × 4.

EXAMPLE.

Let it be required to reduce 13 *A.*—2 *R.*—37,6 *P.* into decimal parts of an Acre.

Set down your Acres, Roods, Perches, and their decimal parts, accordingly as is done in this Example, in the Margin: For by so placing your numbers, you have divided your Perches by 10, which you must also again divide by 4, saying, 4 is in 37 9 times, remains 1; then 4 is in 16 4 times, remains nothing: So Perches 37,6 are reduced unto 0,94 of a Rood. Then Roods 2,94 being divided by 4, the quotient will be 0,735, being the decimal parts of an Acre, and are to be written after 13 *Ac.* according to the Example. So 13 *A.*—2 *R*—37,6 *P.* will be reduced unto Acres 13,735.

10)	4) 3,76
	4) 2,94
	13,735

So

10 × 4) 1,88
4) 3,47
6,8675

So likewise 6 *A.* — 3 *R.* — 18,8 *P.* will be reduced unto Acres 6,8675.

To reduce Statute Acres of 16,5 *foot in a Perch, into Woodland Acres of* 18 *foot in a Perch*;

Say, 144 . 121 :: Statute Acres . Woodland Acre.

EXAMPLE.

How many Acres of Woodland measure are contained in 18 *A.*— 3 *R.*— 09,5 *P.* of Statute measure?

10 × 4) 0,95
4) 3,2375
18,809375

First, reduce 18 *A.* — 3 *R.* — 09,5 *P.* into Acres and decimal parts, by the precedent Rule, according as you see it done in the Margin, it will be Acres 18,809375; which multiplied by 121, the product will be 2275,934375; which divided by 144, the quotient will be Acres 15,805: And so many Acres of Woodland measure are contained in 18 *A.*—3 *R.*—0,95 *P.* of Statute measure.

For, 144 . 121 :: 18,809375 . 15,805.

And contrary, *To reduce Woodland Acres into Stature Acres*;

Say, 121 . 144 :: Woodland Acre . Statute Acre.

Or if you plot by a Scale of 12, and cast up the content by a Scale of 11, you will find the content in Woodland measure. And contrary,

Having the length of an Acre of Land given in Chains, to find the breadth;

Divide 10 by the length given, the quotient will shew the breadth.

EXAMPLE.

Let the length given be Chains 12,25, I demand the breadth of an Acre.

Divide 10 by 12,25, the quotient will be 0,8; the breadth sought.

And likewise, if the breadth given be 0,8, divide 10 by 0,8, the breadth given, the quotient will shew Chains 12,25, the length sought.

If the want of Decimal Arithmetick shall make these Examples seem difficult, (which are very plain, brief and easie,) they may repair to my Book of Arithmetick, where they may, as well as in Vulgar Arithmetick, find ample satisfaction in this of Decimals; to which Book I refer the Reader.

CHAP.

CHAP. V.

How to lay out ſeveral Furlongs in Common Fields unto divers Tenants.

HAving plotted the whole Field, Common, or other Incloſure, with its particular bounds, as you obſerve them in the ſurvey of the whole Manor, (or if you only ſurvey that particular, you muſt take ſpecial notice of all the bounds thereof) then provide a Book or Paper which muſt be ruled or divided into 8 Columns; in the firſt whereof towards the left hand is to be written the Tenant's Name, and the tenure by which he holds the ſame Land: The two next Columns are to contain the length of every man's Furlong in Chains and Links; in the two next Columns is expreſſed the breadth of every man's Furlong in Chains and Links. As by the Letters over the head of each Column doth appear.

In the three laſt Columns is to be expreſſed the quantity of each Tenant's Furlong in Acres, Roods and Perches.

In the laying out of ſeveral parcels in this kind, you will have uſe only of your Chain. Then when you begin your Work, you muſt firſt write the name of the Field; and in the firſt Column of your Book or Paper you muſt write the Tenant's Name, and the tenure by which he holds the ſame, from what place you begin to meaſure, and upon what point of the Compaſs you paſs from thence; and obſerving this direction in all the reſt, you may (if need require) bound every parcel.

This being noted in your Book, obſerve the ſpecies or ſhape of the Furlong, whether it be all of one length or not. If of one length, then you need take the length thereof but once for all; but if it be irregular, that is, in ſome places ſhorter and in others longer, then you muſt take the length thereof at every ſecond or third breadth, and expreſs the ſame in your Book under the title of Length. As for the expreſſing of the ſeveral breadths, you need but to croſs over the whole Furlong, taking every man's breadth by the middle thereof, and entring the ſame as you paſs along: But in caſe there be a conſiderable difference at either end, then I would adviſe you to take the breadth at either end, and find a line which ſhall be in proportion between them a mean breadth, and enter this in your Book or Paper under the title of Breadth.

In this manner you may proceed from one Furlong to another, 'till you have gone through the whole Field: Which when you have done, and noted down the ſeveral lengths and breadths in your Book, you may multiply the length and breadth of every parcel together, as is taught before, and ſo ſhall you have the quantity of every parcel by its ſelf; which quantity muſt be noted down in the three laſt Columns of your Book, as in the following Example appears.

Mordon Field.

The Tenants names and tenure.	*Length.* C.	L.	*Breadth.* C.	L.	*Content.* A.	R.	P.
Abel Johnſon, from the pond S. E. Free.	32	76	3	45	11	1	12
Nicholas Somes, for three Lives.	30	12	2	63	7	3	30
Robert Dorton, for Life.	28	60	8	12	23	0	36
James Norden, at Will.	25	11	12	35	31	0	2

CHAP. VI.

How a Lordſhip lying in Common Field is to be incloſed.

IT moſt commonly happeneth, when a Lordſhip is to be improved wherein are many Free-holders, that their ground (conſiſting of different Qualities) lies for the moſt part diſperſed, and intermixt one amongſt another in all parts and quarters of the Field. Therefore to find the juſt Quantity of every Man's Ground, both Arable, Ley-ground and Meadow, the Surveyor is to prepare a Field-book, wherein, towards the right hand of every Page, let there be three ſmall Columns diſtinguiſhed one from another by a black line made with a Pen or Pencil, and one greater Column towards the left hand, which ſhall contain the butting, bounding and number of every Man's particular Lands, Leys, Doles of Meadows, or the like. Which being thus fitted for uſe, the Surveyor, when he comes into the Field, is to begin in ſome corner thereof, as he ſhall find moſt convenient for taking the Field in order: And then entring upon the Furlong, he ſhall firſt ſet down the name of the Furlong, and upon what point of the Compaſs he begins; next put down the name of the Free-holder that firſt begins it, with the number of his lands; againſt which, in the firſt of the three leſſer Columns, write the length of the lands, in the ſecond put the breadth, and in the third and laſt the quantity. Which done, ſet down the name of the Free-holder that lies next, and the number of his Lands, together with the length, breadth and quantity, as before: And ſo proceed in order 'till you have finiſhed the Furlong

Then go to the next Furlong, writing the name thereof, and where you begin, and proceed as before; and ſo on from Furlong to Furlong, 'till you have finiſhed the Field. But to explain it farther, I ſhall here give you a more particular draught of the Field-book.

The

The Survey of the Lordship of PILTON, *in the County of* Rutland, *made in* Octob. 1656

Middle-Hill Furlong begin. South.

	Leng. P.	*Bread.* P.	*Quantity.* P.
John Falkner 5 lands	51.18	7.60	393.9680
Tho. Tomblinson 2 lands	49.42	3.29	150.6150
Peter Blackley 8 lands	47.10	10.16	478.5360
Abraham Falkner 6 lands	46.70	7.12	332.5040
Tho. Tomblinson 1 land	45.00	1.30	58.5000
John Falkner 10 lands	44.15	12.00	529.8300
Thomas Falks 6 lands	44.00	8.00	352.0000
Andrew Cook 3 lands	43.10	4.11	176.9560

West Furlong begin. East.

Tho. Tomblinson 1 land	36.20	2.50	90.5000
The Parsonage 4 lands	34.80	8.10	281.8800
John Falkner 6 lands	34.00	11.0	374.
Peter Blackley 2 lands	34.00	4.0	136.
Henry Swift 5 lands	34.00	9.20	312.8000
Abraham Falkner 4 leys	33.50	7.0	234.5000
The Parsonage 4 leys	33. 0	7.0	231.
John Falkner 1 ley	33. 0	2.50	82.5000

South Meadow begin. East.

Peter Blackley one dole	36.20	2.50	90.5000
John Falkner 1 dole	40.00	8. 0	320
Abraham Falkner 1 dole	42.00	10. 0	420
The Parson one dole	41.00	8. 0	328
Tho. Tomblinson 1 dole	40.50	6.50	263
Thomas Falks one dole	40.00	6.00	240
Andrew Cook one dole	40.00	6.00	240
Peter Blackley two doles	40.00	11.50	460
John Falkner one dole	39.50	3.00	118.5000

Red-hill Furlong begin. South.

John Falkner 3 lands	45.00	12.0	540
Abraham Falkner 10 lands	45.00	20.0	900
Tho. Thomblinson 3 lands	45.00	12.0	540
The Parsonage 3 lands	50.00	12.0	600
Peter Blackley 6 leys	50.00	20.0	1000
Henry Swift 2 leys	50.00	5.0	250
Thomas Falks 4 leys	50.00	10.0	500
Andrew Cook 1 land	50.00	2.0	100
Peter Blackley 8 lands	50.00	4.0	200

Having

Having finiſhed your rough Book (after this manner,) you are next to make a Particular of every man's Arable, Leys, and Meadow-ground ſeverally, that ſo you may be ready to give a juſt account of what every man holds diſtinctly, that by help thereof you may be enabled (with the help of Arbitratours choſen to aſſiſt you) to give every man, not only the true quantity in his Plot, but alſo conſideration for the Quality of his ground, as near as may be.

To which end, in drawing your particular you are to make ſo many Columns as there are Free-holders, every one whereof is to be ſubdivided into three; ſo ſhall you have one for Arable Land, another for Ley-ground, and a third for Meadow. Then turning to the Field-book, I begin with *John Falkner*, and write in the Particular in its proper Column, under Arable, 393. *P.* 968; then *Thomas Tomblinſon*, 150. *P.* 6150; next *P. Blackley*, 478. 5360. which I place likewiſe under their Names, and in their due place: And ſo I proceed 'till I have finiſhed the Book, placing every Man's Arable, Leys and Meadow in their Order. Which being effected, then make your *Summa totalis*, as you may ſee in the following Synopſis.

A Particular of certain Arables, Leys and Meadow-grounds in part of the Lordſhip of Pilton *Com.* Rutland.

John Falkner			*Tho. Tomblinſon*			*Peter Blackley*		
Arable	Leys	Med.	Arable	Leys	Med.	Arable	Leys	Med.
393	82	320	150		263	478	1000	90
529		118	58			136		460
374			90			200		
540			540					
1836	82	438	838	0	263	814	1000	550
	1836			838			814	
	82			0			1000	
	438			263			550	
Sum. tot.	2356		*Sum.*	1101		*Sum.*	2364	

Abraham Falkner			*Thomas Falks*			*Andrew Cook*		
Arable	Leys	Med.	Arable	Leys	Med.	Arable	Leys	Med.
332	234	420	353	500	240	176		240
900						100		
1232	234	420	352	500	240	276	0	240
	1232			352			276	
	234			500			0	
	420			240			240	
Sum.	1886		*Sum.*	1072		*Sum.*	516	

The

The Particular being finiſhed, I next proceed to take a general Survey and Plot of the whole Field to be incloſed, according as hath been ſhewed at large in the former Chapters. Which being done, you ſhall ſee if the general Survey and the Particulars agree: Which if they do, you may conclude your work is exact; and then you may proceed to the plotting of every Man's Ground, and to lay it out in ſuch part of the Field as the Free-holders (or their Arbitrators) ſhall agree: And when that is done, you are to do in like manner with the reſt. And at laſt, when a Plot of the Town, Streets, Lanes, Houſes, Woods, and all the new Incloſure, ſhall be garniſhed with Colours upon Vellum or Royal Paper, it will moſt neatly ſhew the true proportion, and Symmetry thereof.

And laſtly, let there be a Book drawn very fair, ſhewing the Butting, Bounding, and Quantity of every ground.

An Advertiſement, *concerning the Meaſuring of* Lands, *or* Furlongs, *in* Common-Fields.

IT often times falls out, that in the *Surveying* of *Lordſhips*, *Manors*, *Farms*, &c. That a conſiderable part belong to ſuch *Demeaſne*, may lie diſperſed in *Common-Fields*, in ſeveral *Shots*, and in ſeveral *Lanes* in thoſe *Shots*, which cannot be laid down in their true Poſitions, without the whole *Field* be firſt *Platted*, which very rarely, any ſingle *Proprietor* will be at the *Charges* to have done: And, foraſmuch as ſuch *Lands* or *Furlongs* are generally *reputed* to be *One*, *Two* or *Three Acres*, *Half-acres*, *Quarters*, or the like, they ſeldom fall out to be found ſo much by *Meaſure*: I do therefore ſometimes, in ſuch *Caſes*, inſert in ſome vacant place in the *Plot* of the *Mannor*, *Farm*, &c. in which ſuch *Common-Fields*, *Lands* is a part, add ſuch a *Table* as this following: Whereby, any ſingle *Lands* or *Furlong*, may be found in ſuch *Common-Fields*, with what *Shot* it is in, its *Boundaries* on all ſides; its *Length*, *Mean Beadth*, and *Real Content* by *Meaſure*, and alſo the *Reputed Quantity* thereof, and ſo diſcover the *Difference*. View the following *Table*.

The Parcels of Land belonging to the Mannor of *Coxon*, lying in *Norcot* Great-Field, with their Boundaries and Contents, both Real and Reputed.

	East.	West.	North.	South.	Length		Mean Breadth		Content Real.			Content Reputed		
					C.	L.	C.	L.	A.	R.	P.	A.	R.	P.
4 *High-way* Shot	*Ch. Cheesman*	*N. Watson*	*Fr. Childe*	*Tho. Barnard*	6	60	1	45	0	3	33	1	2	0
2 *East* Shot	*N. Whatson*	*Ch. Gray*	*Joh. Windsor*	*Tho. Barnard*	10	95	0	80	0	3	20	1	0	0
1 *Head*-Land	*Joh. Windsor*	*Nic. Watson*	*Joh. Hilliar*	*Ch. Gray*	6	92	0	73	0	2	0	0	2	0
7 *Head*-Land	*Joh. Windsor*	*Nic. Watson*	*R. Faulkner*	*Ch. Cheeseman*	7	30	1	15	0	3	14	1	0	0
1 *East-way* Shot	*Joh. Windsor*	*Fr. Hampton*	*Joh. Hilliar*	*Ch. Cheeseman*	9	67	0	35	0	1	14	1	0	0
1 *East* Shot	*Joh. Windsor*	*Fr. Hampton*	*Fr. Hampton*	*Ch. Gray*	9	75	0	30	0	1	07	0	2	1
3 *East* Shot	*Rob. Hampton*	*Ch. Cheeseman*	*Rob. Hampton*	*Tho. Assiter*	9	00	0	51	0	2	30	1	0	0
1 *High-way* Shot	*Ch. Cheeseman*	*Ch. Cheeseman*	*Rob. Hampton*	*Tho. Assiter*	6	40	0	75	0	1	33	0	3	0
1 *East* Shot	*Rob. Assiter*	*John Horn*	*Ch. Gray*	*Tho. Barnard*	9	00	0	42	0	1	22	0	2	0
4 *High way* Shot	*Nic. Watson*	*Th. Assiter*	*Ch. Cheeseman*	*Ch. Gray*	7	92	1	65	1	1	10	1	2	0
5 *High-way* Shot	*Nic. Watson*	*Ch. Cheeseman*	*Ch. Greg*	*Ch. Cheeseman*	6	85	1	70	1	0	25	1	2	0
1 *Long* Shot	*Rich. Faulkner*	*Will. Mead*	*Ch. Cheeseman*	*Ch. Gray*	14	10	0	46	0	2	26	1	0	0
6 *Long* Shot	*Rich. Faulkner*	*Rob. Assiter*	*Ch. Cheeseman*	*Ch. Cheeseman*	14	60	1	53	2	0	33	2	2	0
2 *Long* Shot	*Rich. Faulkner*	*Rob. Assiter*	*Ch. Cheeseman*	*Joh. Brent*	14	50	1	38	2	0	0	2	2	0
1 *West* Shot	*Tho. Assiter*	*Ch. Gray*	*Ch. Gray*	*Ch. Gray*	9	80	0	65	0	2	21	0	3	0
1 *West* Shot	*John Short*	*Joh. Brent*	*Ch. Gray*	*Th. Barnard*	7	45	0	67	0	1	34	0	2	0
1 *Head* Land	*R. Franklin*	*Fan. Childe*	*Ch. Gray*	*Th. Barnard*	7	90	0	72	0	2	10	0	3	0
1 *Pendle* Shot	*Fran. Childe*	*Ch. Cheeseman*	*Fr. Childe*	*Tho. Barnard*	10	90	0	30	0	3	35	1	0	0
3 *Pendle* Shot	*Ch. Gray*	*David Cole*	*Nic. Watson*	*Tho. Barnard*	10	10	0	80	0	3	09	1	0	0
				The Sums—					8	1	16	20	3	0

CHAP. VII.

To find the Horizontal line of any Hill or Mountain.

THis Performance differeth nothing from what is before taught in the taking of Altitudes, in the beginning of the Fourth Book. Wherefore ſuppoſe you ſhould meet with a Hill or Mountain as A B D, (*Fig.* 39.) the thing required is, to find the length of the line B D on which the Mountain ſtands.

Firſt, place your Inſtrument at the very foot of the Hill, exactly level: Then let one go to the top of the hill at A, and there place a Mark, which muſt be ſo much above the top of the Hill, as the top of the Inſtrument is from the ground: Then move the Label up and down, 'till through the ſights thereof you ſee the top of the mark at A, and note the degrees cut by the Label on the Tangent line, for that is the quantity of the angle A B C, which ſuppoſe 47 degrees; then by conſequence the angle B A C muſt be 43 degrees, the complement of the former to 90 degrees: Then meaſure the ſide of the Hill A D, which ſuppoſe to contain 71 feet: Then in the Triangle A B C there is given the ſide A B 71 feet, and the angle B A C 43 degrees, together with the right angle A C B 90 degrees, and you are to find the ſide B C; which to perform, ſay,

As the Sine of the angle A C B, 90 degrees,
is to the ſide A B, 71 feet;
So is the Sine of the angle B A C, 43 degrees,
to the ſide B C, 48½ feet.

Then (becauſe the hill deſcends on the other ſide) you muſt place your Inſtrument at D, obſerving the angle A D C to contain 41 degrees, and the angle D A C 49 degrees, and the ſide A D 80 feet. Now to find the ſide C D the proportion will be,

As the Sine of the angle A C D, 90 degrees,
is to the ſide A D, 80 feet;
So is the Sine of the angle C A D, 49 degrees,
to the ſide C D, 60½ feet.

Which added to the line B C giveth 109 feet; which you may reduce into Chains, by dividing it by 66: And this line muſt be protracted in ſtead of the Hypotenuſal lines A B and A D.

CHAP.

CHAP. VIII.

How to plot Mountainous and uneven grounds, with the best way to find the Content thereof.

FOR the plotting of any Mountainous or uneven piece of ground, as ABCDEFG (*Fig.* 38.) you must first place your Instrument at A, and direct the sights to B, measuring the line A B: Then in regard that from B to C there is an ascent or hill, you must find the Horizontal line thereof, and draw that upon your Table, accounting thereon the length of the Hypotenusal line: Then measure round the Field according to former Directions, and having the figure thereof upon your Table reduce it into *Trapezia's*, as into the *Trapezia's* ABEG, BCDE, and the Triangle GEF: then from the angles A, C, E, and F, let fall the Perpendiculars A K, C H, E I, EL, and F M. Now in regard there are many Hills and Vallies all over the Field, you must measure with your Chain in the Field over Hill and Dale, from B to D; and to the line B D, set the number of Chains and Links as you find them to be by such measure, which will be much longer then the straight line B D measured on your Plot by the Scale. Then by your Instrument find the point H, in the line B D, and measure from C to H as before, and set to it the number as you find it by the Chain. Then find the Perpendicular I E, and measure that with your Chain also: All which lines (in respect of the Hills and Vallies) will be found longer, then if they were measured upon the Plot by the Scale: And therefore by the lines B D, C H, and I E, as they are thus measured, must the *Trapezia* B C D E be cast up, as also the *Trapezia* A B E G, and the Triangle G E F: And this is the exactest way that I can prescribe for the measuring (or finding the true Contents) of uneven Grounds; which being carefully, and with discretion performed, will not differ much from truth. For, if such uneven Grounds should be Plotted, according to their true measures in the Field, they would not be contained within their proper limits, which laid down among other Grounds would swell beyond their bounds, and force the adjacent Grounds out of their places.

But now, to distinguish these Grounds from others in your Plot, you may shadow them off with Hills as in this Figure, lest any man seeing your Plot, should measure by your Scale, and find them to differ.

CHAP.

CHAP. IX.

Of the Mensuration and Plotting of Roads, High-ways, Streets, Lanes, &c. And of the taking of the Ground-plot of Cities, Towns, or Hamlets.

HE that well understandeth and can put in practice what is delivered in the former part of this *Fourth Book*, cannot but perform what is intended to be taught in this *Chapter*; therefore I shall only discourse the manner how these things are to be performed, leaving the Practice thereof to the ingenuity of the Learner.

For Roads *or* High-ways.

In the describing of Countries, there is no fitter Instrument for the performance thereof then the *Circumferentor*, and that Card which is divided into 4 Quadrants, each divided into 90 degrees, beginning from the *North* and *South*, and numbred towards the *East* and *West*, as is described *Book* 2. *Chap.* 10.

Then, have a *Field-Book* for that purpose, (the fittest is in a long Folio, like your narrow Shop-Book) with two Parallel Lines drawn through the middle of each Page, the distance between which need not be above half or three quarters of an Inch.

Now at the beginning of your Journey, at the bottom of one of the Leaves of your Book, write the name of the place where you begin your Journey, and a Prick or this Mark ⊙ between the Parallel Lines. Then setting forward, always carry one of the Cardinal Points of the Compass either *North* or *South* before you, and direct your Sight so far as you can see along the Road, noting the Degrees that the Needle cuts, and in what Quarter of the Compass, which you may call the Bearing; and when you come to that place, write down the distance, in *Paces*, *Chains*, or whatsoever *Measure* you measure by, between the Parallel Lines.

Then again direct your Sight forwards, so far as 'till you can see another turning or bend, and note down the Degrees of Bearing, and which way; and when you come to that place, set down the distance thereto from the last Station. And in this manner proceed 'till you come to your Journey's end.

Now in your Perambulation you are to observe, 1. What *By-lanes* or *Turnings* you meet withal in your way, whether they be on your Right hand, or on your Left, and at what distance from your last Station; as if there be a *Lane* on your Right hand 300 Paces from your last Station, you must on the Right hand Parallel Line

make two little Strokes thus =, bending them either upwards, or downwards, or ſtraight at right Angles, according as you ſee the Lane to incline this or that way: And at the end of theſe two Parallel Lines write the name of the Place to which that Lane leaneth, and if you will, or can obtain it, the reputed diſtance thither; and and under the Line write the diſtance from your laſt Station 300.

2. When you paſs over any eminent *Bridge*, by any *Wind mill*, over any *Great Hill*, through any *Town* or *Village*, note them all down with their diſtances from your laſt Station.

3. In your going along the Road, if you ſee any *Churches*, *Manſion-Houſes*, *Beacons*, *Wind-mills*, *Towns*, *Villages*, or any other thing remarkable; at your next Station ſee how they bear from you, writing down their names, and how they bear from you, on that ſide of the Book on which they lie from you.

Then in your Journeyings forwards, when you come to ſee thoſe things or Places, or ſo many of them as you can, there take notice alſo how they bear, and their names alſo, with the diſtance from the laſt place where you obſerved them before; and continuing this Method, you may accurately deſcribe the Roads of any Country.

For Streets *or* Lanes *in* Cities *or* Towns.

1. In the Plotting of *Streets*, there muſt be ſomewhat more exactneſs uſed then can poſſibly be in *Roads* and *High-ways*: for *Roads* being both long and large, cannot be plotted by any other then a very ſmall *Scale*, ſo that every ſmall bout, or turning, cannot be taken notice of; or if they be, they cannot be expreſſed in any *Plot*: but in *Streets* and *Lanes* every ſmall *bowing*, though it make not an angle of above 3 or 4 degrees, muſt be taken notice of; and therefore the *Theodolite* or *Semicircle* is more apt and fitter for this work then the *Circumferentor*. Yet in this you need not with your *Inſtrument* make obſervation of theſe ſmall Angles, but having made obſervation of 4 eminent angles and the principal intermediat ones, you may by the help of *Rods* or other *Bevels* for that purpoſe more accurately find the quantity of thoſe Breaks and Angles, and thoſe alſo will be leſs troubleſome.

2. When you have by your Inſtrument made obſervation of ſo many grand Angles in *High-ſtreets*, as to do encompaſs divers other ſmall *Streets* or *Lanes*, you muſt remember to take ſpecial notice of your Station-Points; and in meaſuring with your Chain, take notice, as you paſs by them, of all manner of *Breaks*, *Courts*, *Allies*, *Houſes* of note, and other publick *Remarks*, with their true perpendicular diſtance from your Chain, taking both ſides of the way in every *Street* or *Lane* together.

3. Having protracted your Four, or more Grand or Cardinal Angles, firſt, lay down theſe four principal *Streets*, (and here you may examine by your Angles whether they will cloſe or not, by the directions given in the 4 *Book*,) and on either ſide of the way make Marks,

Marks, as this ⊙ or the like Mark, where any other *Croſs-ſtreet* or *Lane* enters, as alſo all *Courts*, *Allies*, and the like.

4. Plot your ſeveral By-lanes with the ſeveral Bows and Breaks in them, and take notice of the *Courts* and *Allies* that are in them; making Marks at their entrances, as you did of thoſe By-lanes in your *High-ſtreets*.

5. With *Rods* or a *Bevel*, take the Plot of all *Courts* and *Allies*, and eminent *Houſes*, &c. And having taken all theſe in a Book, you may plot and tranſfer them into your *Map*, between the eminent *Streets* that you firſt took your Angles in. And thus having taken one Part or Quarter of a *Town* or *City*, you may proceed to another, and ſo one after another, 'till you have finiſhed what you intend to have a Plot of.

This is the beſt and moſt accurate way that I can preſcribe for the plotting of *Cities* or *Towns*, and it is the way which I my ſelf uſe in my Survey of the *City* of *London*, as it is now re-edified; wherein I take notice of all remarkable things therein. For, beſides the *High-ſtreets*, and *Streets* of note, I take notice of, and Plot, all *By-ſtreets* and *Lanes*, all *Courts* and *Allies*, all *Churches* and *Church-yards*, and the 2 *Temples*, all *Inns* of *Court*, all *Colleges*, the *Guild hall*, and all eminent *Halls* of *Corporations*, all *Market-places* and *Market-houſes*, &c. This task is now under my hands, and I hope with God's aſſiſtance in a few Months to compleat it.

CHAP. X.

How to inlarge or diminiſh a Plot, according to any aſſigned proportion.

IT may ſo fall out, that when you have taken the Plot of a whole Mannor upon your *Plain Table*, in divers ſheets of Paper, or obſerved the Angles, and afterwards protracted them, it may, I ſay, ſo fall out, that your Plot may be either bigger or leſſer than is deſired. Now if at any time it be required to inlarge or diminiſh any Plot according to any proportion, this Chapter will accompliſh your deſire.

The Inſtruments for the performance hereof are divers, as was intimated in the 12 *Chapter* of the Second *Book*. Now for generality and exactneſs, the two Indices there ſpoken of, having at each end thereof a Semicircle, is inferiour to none; but the Inſtrument being very chargeable, and the uſe thereof very intricate and tedious, I ſhall wholly omit to ſpeak any more of it.

There is another way alſo which Maſter *Rathborn* uſed, which was with a Ruler by him invented for that purpoſe; which would indifferent well reduce a Plot from one bigneſs to another, according to ſome particular proportions. The making of this Ruler is

ſo

ſo well known, and the Uſe thereof ſo apparent, that I ſhall not need to ſay any thing concerning the deſcription or uſe of it: I only intimate that there is ſuch a Ruler, that thoſe which pleaſe may have it made.

Another way is by one Line divided into 100 or 1000 equal parts only, which by the help of Arithmetick will perform this work very well: But this (as being very tedious) I neglect.

To paſs by theſe and divers others which I could name, I ſhall ſay ſomething of the *Parallelogram*, which for generality, exactneſs, and diſpatch, ſurpaſſeth all the reſt, unto which (in my opinion) there is none comparable. Of *Parallelograms* there are divers ſorts, but that which I ſhall inſtance in, conſiſteth but of four Rulers only; the making wherof is well known to the Inſtrument-maker, and the manner of uſing it as followeth.

Take the Plot which you would reduce, and faſten it to a Table with Mouth-glew; then by it, upon the ſame Table, faſten your fair Paper or Parchment, upon which you would have your new Plot: Then, having fitted your *Parallelogram* according to the proportion to which you would have your Plot reduced, fix the *Parallelogram* to the Table, by a Point for that purpoſe: Then put your drawing Pen into ſome one hole on one of the ſides of the *Parallelogram*, and upon it a Plummet of Lead or Braſs, to keep the Pen down cloſe to the Paper, when it is moved thereupon. And here Note, that at any time when the *Parallelogram* is thus fitted, the Point that ſticketh in the Table, the Pen which is to draw, and the Tracer which you muſt move along the Lines of your old Plot, will lie always in a right Line: But this by the way. Your *Parallelogram* being fixed to the Table, and the Pen in its true place fitted to draw, take the Tracer in your Right-hand, and with it lightly go over all the Lines of your old Plot; ſo ſhall the motion thereof occaſion the Pen to draw upon your clean Paper or Parchment the true and exact Figure of your former Plot, though of another bigneſs, which will be in proportion to the greater according to the ſituation of the ſides of the *Prarallelogram:* Which will better appear by the ſight of the Inſtrument, then words can poſſibly explain it.

Another way how to reduce a Plot according to to any proportion aſſigned, is this. Suppoſe you would have a Plot diminiſhed in proportion as four to three. Cauſe a Scale to be made of ſuch a length, that it may reach from the center or the middle of your Plot to the outermoſt Angle thereof, which let be divided into 100, 1000, or 10000 parts, according to the length thereof: then let another Ruler be made, which ſhall be in proportion thereto as 4 to 3, which Ruler let be divided into the ſame number of equal parts as the other Ruler was. Being thus provided of two Rulers, lay by your large Plot upon a Table, faſtning it at the Corners with Mouth-glew; and underneath it lay your fair Paper or Parchment: Then number all the Angles in the Field with Arithmetical Figures, beginning with the outermoſt Angle, calling that one, the next two, the third three, and ſo forth: Then as you move the

Ruler

Ruler from Angle to Angle, take notice what number of equal parts is cut by every Angle, and note them down in Paper; then take off your longer Ruler, and lay on your ſhorter in the place thereof, ſo moving it from Angle to Angle, and pricking holes with a ſmall Protracting Pin quite thro' the old Plot. So when you have gone over every Angle, you may upon your clean Paper or Parchment draw Lines from Point to Point, 'till you have gone over all the Angles: So ſhall your Plot be reduced to your intended bigneſs.

Again, there is another way how to reduce Plots to any proportion, and that is this. About your foul Plot draw the largeſt Square you can, ſo that it may comprehend your whole Plot, and divide that Square into as many ſmall Squares as you pleaſe: Then make another Square in proportion to the Square about the foul Plot, as to which you would have it reduced: And then laying your foul Plot and the fair Squared Paper both before you, ſee in which of the ſmall Squares of the foul Plot the ſeveral Angles or remarkable Points fall, and in the correſpondent Square of the fair Paper make the like Angle or Point: And in this manner proceed till you have finiſhed your Work. This is a good way, and is the courſe which *Painters* uſe to copy any large Painting into a ſmaller Picture or Print. This method is to be uſed when you are to reduce a leſſer Plot to a greater: But to reduce a greater to a leſſer, which is moſt uſual, you may then lay your fair Paper under or over your foul Plot, and fix the *Parallelogram* about the middle of the Plot, and then tracing over the latge Plot, you ſhall have it reduced upon the fair Paper, either over or underneath; eſpecially if you lay a Black-lead Paper over your fair Paper.

CHAP. XI.

How to draw a perfect draught of a whole Manor *or* Lordſhip, *and to furniſh it with all neceſſary Ornaments; alſo to adorn and beautify the ſame with Colours; in which (as in a Map) the Lord of the Manor may at any time ſee the ſymmetry, ſituation and content of all or any parcel of his Land.*

Fig. XIV. HAving protracted your Plot according to your intended bigneſs, and written the Content of each Cloſe about the middle thereof, you may about the bounds of every Field or Incloſure, with a ſmall Pencil, and ſome tranſparent Colour, neatly go over your Black Lines; ſo ſhall you have a tranſparent ſtroke

or margent on either ſide of your Black Line; which being ſhadowed will add a great luſtre and beauty to your Plot.

Then in your Wood-land Grounds, draw divers little Trees in the moſt material places, and ſhadow your mountainous and uneven Grounds with Hills and Valleys, expreſſing all kind of Bogs, Groves, High-ways, Rivers, *&c.* diſtinguiſhing them by lively Colures, according to their ſimilitudes.

Then in ſome convenient place of the Plot, without the Incloſures, draw a Circle, and therein deſcribe the 32 Points of the Mariner's Compaſs according to the ſituation of the Grounds, with a *Flower-de-luce* at the *North* part thereof.

Then in ſome convenient place of your Plot make a Scale equal to that by which your Plot was protracted, with a pair of Compaſſes upon it.

Laſtly, in ſome other convenient place towards the upper part thereof, draw the Coat of Arms belonging to the Lord of the Manor, with Mantle, Helm, Creſt, and Supporters; or in a Compartment: But be ſure you blazon the Coat in its true Colours.

Theſe things being well performed, your Plot will be a neat Ornament for the *Lord* of the *Manor* to hang in his Study, or other private place; ſo that at pleaſure he may ſee his *Land* before him, and the qnantity of all or every parcel thereof, without any farther trouble.

Alſo in your Plot muſt be expreſſed the *Manor-houſe* according to its ſymmetry or ſituation, with all other Houſes of note, alſo all *Water-mils*, *Wind-mils*, and whatſoever elſe is neceſſary, that may be put into your Plot without confuſion.

For farther explanation of what hath been delivered in this Chapter, I have here added the Figure of a ſmall *Manor*, which will be ſufficient for example ſake. As is *Fig.* XIV.

CHAP. XXII.

The Names of ſuch Colours as are neceſſary for the Waſhing of Maps, Charts, or Plots, with the manner how to temper and uſe the ſame upon Velom, Paper, or Parchment.

IT is not convenient for a *Surveyor*, when he hath drawn the draught of a *Manor*, and reduced it to his intended bigneſs, to repair to a *Painter* to finiſh his Work, the thing it ſelf being very commendable, and eaſy to be attained: And beſides, a *Painter* is not to be found in every Country, nor is every *Painter* furniſhed with Colours fitting for ſuch a purpoſe, they for the moſt part uſing more groſs and ordinary Colours. Now for the benefit of ſuch

ſuch who deſire to exerciſe themſelves in this kind of practice, I have added theſe neceſſary Directions following.

How to make Gum-Water.

Take *Gum Arabick* what quantity you pleaſe, of the whiteſt and cleareſt you can get, which bruiſe into ſmall pieces, and tie them up looſely in a fine Linen Rag: Then take of the cleareſt Water you can get, and put it into a clean Veſſel, as a Porringer, (or ſuch like) then hang your Cloth in which you put your *Gum* in this water, letting it hang till all the *Gum* be diſſolved: Then when you put your Fingers into this Water, if you find them to ſtick together as if they were glewed, your Water is too ſtiff of the *Gum*, which you may remedy by putting thereto more fair Water; and if you find it to weak, you may add more Gum. With this Water moſt Colours are to be tempered.

How to make Allum-Water.

TAke a pound of *Allum*, and beat it to powder: Then take a Gallon of clean Water, and ſet it on a fire, letting it boil 'till all the *Allum* be melted: Then take it off the fire, and when it is cold you may put it into a Veſſel, and keep it for your uſe. With this Water if you wet your Paper before you lay on your Colours, it will keep them from ſinking into the Paper, and will alſo add a luſtre and beauty to the Colours laid thereon.

The Names of ſuch Colours as are neceſſary for the Waſhing of Maps, Plots, or Charts.

REDS	YELLOWS	BLEWS	GREENS
Vermilion	Gumbooge	Bice	Bice
Lake	Yellow Berries	Indigo	Sap Green
Red Lead	Orpiment, *i. e.* Arſnick	Verditer	Vertdegriece
Roſſet	Maſticot.	Litmoſe	Verditure.
Brazeel		Logwood.	
Turnſoil			
Indian Cakes.			

BLACKS	WHITES	BROWNS
Lamp black	White Lead in flakes.	Spaniſh Brown
Printers Black		Umber
Ivory } Shavings		Wood Soot
Hartſhorn } burnt.		Rindes of green Wall-nuts.

Being thus provided of theſe ſeveral Coloures here named, which you may have in divers places in *London*, as alſo of a Grinding-ſtone and Muller, which any Maſon in *London* will furniſh you with, alſo divers Pencils of ſeveral ſizes, and Gally-pots, Gar-Glaſſes, or Horſe-Muſcle-ſhells, to put your Colours in when they are ground and tempered, you are then ready at any time to make uſe of them. And now will I ſhew you how all the fore-mentioned Colours are to be ground and tempered.

Of the Ordering of Colours.

Of theſe Colours before mentioned, ſome are to be Ground ſome Waſhed, ſome only Steeped or diſſolved, others to be Boiled, and ſome to be Burnt, and then Ground.

1. *How any Colour is to be Ground.*

Take what Quantity of any Colour you pleaſe, that is to be Ground, and lay it upon your *Grinding-ſtone* being clean, as alſo your *Muller*; then with your *Muller* bruiſe the Colour, if it be lumpiſh, and when it is reaſonable ſmall or fine, put ſome fair Water to it, and with your *Muller* grind the Colour and Water together till it be very fine: Then with a *Knife* or piece of thin *Lanthorn-Horn*, bein clean, take it off from the *Stone*, and put it into a *Shell*; and when it is dry, you may take it out of the *Shell*, and keep it for your uſe.

The Colours to be Ground are.

Vermilion Lake Indigo Maſticot White Lead.

In grinding of your Colours put not too much Water to them upon the Stone, for they ought to be ground ſtiff like weak Paſte, or Pap.

2. *How Colours are to be Waſhed.*

Take a good quantity of the Colour which you intend to Waſh, and put it into a Baſon, pouring to it a good quantity of fair Water, and ſtir the Colour and the Water often together, and then you will ſee a great deal of filth ſwim at the top of the Water. When the Colour is ſetled to the bottom of the Baſon, pour away that Water gently into another Veſſel or Baſon, and pour more fair water to the Colour, then ſtir the Colour and that freſh water together; and when the Colour is ſettled, pour away that ſecond water to the former, and ſo put a third and fourth water, ſtirring it often,

'till

'till the water come from the Colour without filth, then is your Colour waſhed. But before you take the Colour out of the Veſſel, lay it with your hand very thin about the ſides of the Veſſel, and when it is dry, ſome of it will fall to the bottom, which put out upon a Sheet of Paper, which will be good Colour; but the remainder, which ſticks to the ſides of the Baſon, is beſt of all, which with a Feather ſtrike off the ſides of the Veſſel, for it will be finer then any Flower.

The Colours to be Waſhed are

Roſſet	Bice	Orpiment
Red-Lead	Verditer	Spaniſh Brown.

Theſe or other Colours thus waſhed, you may reſerve in white paper free from Duſt, and make uſe of them as you have occaſion.

3. *How Colours are to be Steeped.*

This is only to put the Colour into ſome kind of Liquor and there to diſſolve it; ſome in cold Liquors, others upon the fire.

The Colours to be Steeped in cold Liquors are

Yellow Berries	Sap Green	Vertdegriece
Gum Buge	Litmoſe	Indian Cakes.

The Colours to be Steeped or Boiled are

Braſil	Turnſoil
Logwood	Wood Soot

Rinds of Wall-nuts.

Theſe Colours when ſteeped or boiled are to be kept cloſe in *Glaſſes*, 'till you have occaſion to uſe them.

4. *How Colours are to be Burned.*

Some uſe only to put a lump of Colour into a red-hot place of the fire, and there let it lie 'till it be throughly burnt: But this is both waſtful and ſlovenly. *The beſt way is this:*

Take a quantity of your Colour, and put it into a clean *Crucible*, putting thereto ſome fair Water: Then cover the *Crucible* with *Clay*, and ſet into a hot place of the fire, letting it there continue 'till the *Crucible* be red hot: Then take it out, and when it is cold you may take out the Colour, and grind it as is before taught.

The Colours to be Burnt are

Spaniſh Brown	Printers Black	Ivory
Umber	Lamp black	Hartſhorn

or any other groſs and foul Colour.

Having ſhewed you the way how to *Grind*, *Waſh*, *Steep*, *Boil*, and *Burn* your *Colours*, I will ſhew you now.

5. *How to Temper your Colours.*

Firſt, ſuch Colours as are Ground with fair Water, take a ſmall quantity thereof, and put it into a *Muſcle-ſhell*, putting thereto ſome *Gum-water*, and the Colour in a ſhort time will be mollified: Then with your Finger (being very clean) bruiſe the Colour againſt the *Shell*, 'till you find no knots undiſſolved: Then with a clean Pencil ſtroak down the Colour towards the bottom of the *Shell*, and it is fit for uſe; but if it be too thick, add more *Gum-water* to it.

Such Colours as are Waſhed, you muſt temper in a *Shell* with *Gum-water*, in the ſame manner as you did thoſe that were Ground.

Such Colours as are Steeped, the Liquor only of them is to be uſed, without any addition.

Of the ſeveral Simple Colours, how to order them, without any Mixture.

1. Of Reds.

Vermillion, being Ground and tempered with *Gum-water*, makes a deep *Red* or *Scarlet* Colour.

Lake, Ground and tempered with *Gum-water*, makes a deep *Pink* or *Bloom* Colour.

Red Lead, Waſhed, is a brave Orient Colour, between a *Red* and an *Orange* Colour.

Roſſet, Waſhed, and tempered with *Gum-water*, differs not much in Colour from *Lake*, but it will ſoon fade and grow lighter; but being tempered with *Brazeel-water*, it will be more deep.

Brazeel. The Shavings or Grindings thereof, being boiled in *Vinegar* and *Small Beer* (or fair Water) in an earthen Veſſel, with ſome Powder of *Allum* put therein to heighten the Colour, makes an excellent *Pink* or light *Violet* Colour. When you ſtrain the Liquor from the dregs of the *Brazeel*, add thereto ſome *Gum Arabick* to bind it.

Turnſoil. It is made of Linnen Rags died, which being put into a Sawcer, or the like, with ſome *Vinegar*, and ſet upon a Chafindiſh of Coals, the Rags ſqueezed into the *Vinegar*, with

ſome

ſome *Gum* to bind it, makes a good Colour to ſhadow all *Yellows* with.

Indian Cakes. Uſe them as you do *Turnſoil*, and they make a good *Red* tranſparent Colour: Into the Liquor put ſome *Gum* to bind it.

2. Of Yellows.

Gumbooge, Steeped in fair Water only, makes the moſt excellent and moſt tranſparent *Yellow Colour*: It is of that nature, that it will admit of no mixture.

Yellow Berries, Steeped in fair Water, and a little powder of *Allum* added thereto, (or ſteeped in *Allum-water*) makes a very good and tranſparent *Yellow*.

Orpiment, Waſhed, and tempered with *Gum-water*, makes an *Orient* or *Gold Colour*: There are ſeveral degrees of it, ſome more *Red*, and others more *Yellow*.

Maſticote, Ground, and tempered with *Gum-water*, makes a good, but no tranſparent *Yellow*.

3. Of Blews.

Bice, Waſhed, and tempered with *Gum-water*, is an excellent *Blew*, but not tranſparent: And there are ſeveral ſorts of it, ſome *lighter*, ſome *ſadder*.

Indigo, Ground, and tempered with *Gum-water*, makes a deep *Blew*, and is fit to ſhadow all other *Blews*.

Verditer, Waſhed, and tempered with *Gum-water*, is a good *Blew*, but not tranſparent.

Litmoſe, Cut it in ſmall ſlices, and ſteep it in a weak Water made of *Gum Lack*, for the ſpace of a day or more, and you will have a tranſparent *Blew*.

Logwood, Boiled in all reſpects as *Brazeel*, makes an excellent *Violet* or *Purple Colour*.

4. Of Greens.

Bice, Waſhed, and tempered with *Gum-water*, makes a good, but no tranſparent *Green*.

Sap Green, Steeped in fair Water, and a little Powder of *Allum* added thereto, makes a good *Green* to ſhadow or damask withall.

Verditure, Waſhed, and tempered with *Gum-water*, makes a *Green* not tranſparent.

Half a pound of *French Vertdegriece* boiled with a quart of fair Water, and one ounce of *Red Argol*, gently for 6 Hours, make a *Green Colour* inclined to *Blew*, and very tranſparent. If you let it ſettle, and then pour of the clear part for your Uſe, it will be ſtill better if it ſtand continually near a Fire, or as oft as convenience permits, in the Sun.

5. Of

5. Of Blacks.

Lamp Black
Printers Black
Ivory } Shavings
Hartſhorn }
} Being burnt, ground, and tempered with *Gum-water*, are all good *Blacks*.

6. Of Whites.

White Lead, Ground, and tempered with *Gum-water*, is the beſt *White*.

7. Of Browns.

Spaniſh Brown, Burnt, ground, and tempered with *Gum-water*, makes a *Reddiſh Brown*, or *Liver Colour*.

Umber, Burnt, ground, and tempered with *Gum-water*, makes a good *Haw Colour*, and is good to ſhadow upon *Gold*.

Wood Soot
or
Rinds of green Wall-nuts
} Boiled in fair Water, and ſtrained, and ſome *Gum Arabick* put into the liquor, to bind it, either of them makes a moſt excellent Colour for to expreſs *High-ways*, *Lanes*, &c.

Of Mixture of Colours.

All the fore-mentioned Colours that we have hitherto treated of, are ſuch as are ſimply of themſelves, without any mixture, of which infinite may be compounded; nay, almoſt what you will: But for our purpoſe of Colouring *Plots*, thoſe are more preferable, which are moſt tranſparent. Of which *Brazeel* and *Logwood-water*, *Indian Cakes*, *Turnſoil*, *Gumbooge*, *Yellow Berries*, *Litmoſe*, *Sap Green*, *Vertdegriece* diſtilled, *Wood Soot* and *Wall-nut Husks*, are the principal; and of theſe ſeveral others may be compounded.

For Green.

Vertdegriece-water and *Yellow-Berry-water* make a tranſparent *Green*, either ſadder, or lighter, according to the quantity that you take of either.

For Blew.

Litmoſe-water, to which add *Yellow-Berry-water*, and you have a ſad *Blew*.

For

For Orange Colour.

Brazeel-water and *Yellow-Berry-water.*

Infinite Colours I ſay may be made of theſe, which may better be found out by practice then by many Words: And therefore now I will ſhew you what Colours do ſhadow one another.

Concerning Shadowing

All Light Colours are Shadowed with Colours of their ſame nature, but more ſad; for which take theſe brief directions.

Vermilion	Is Shadowed with	Lake, or Spaniſh Brown
Verditer, and Bice		Indigo
Gumbooge, and Yellow Berries		Umber, with Red Lead, or Vermillion
Red Lead		Lake, or Spaniſh Brown
Maſticote		Red Orpiment
Spaniſh Brown		Burnt Umber with Brazeel-water
Umber		Umber burnt
Roſſet, and Brazeel, *&c.*		Spaniſh Brown, mixed with Brazeel-water
Vertdegriece		Indigo and Yellow-Berry-water mixed
Wood Soot, and Wall-nuts.		Umber.

Concerning the laying on of your Colours.

For the laying on of your Colours, you muſt provide your ſelf of *Pencils* of ſeveral ſizes, bigher and leſſer: And if you will be curious, you ought to have a great and a ſmall to each reſpective Colour; if not, you muſt always have by you a Diſh of fair Water, in which you muſt ſwill or cleanſe your *Pencil*, wiping it with a clean Linnen Cloth, before you put it into another Colour.

For your *Pencils*, you may chuſe, in your buying, thoſe that are good in this manner. See that they be fulleſt next to the Quill, deſcending or leſſening into a ſmall room and ſharp Point, which you may produce by putting of the Hair into your Mouth, and drawing it through your Lips once or twice, then may you ſee what it is, and if you find any extravagant Hairs, ſinge them off by a Candle's flame.

Being thus provided with *Colours* and *Pencils*, if you would lay any Colour about the edges of any part or piece of Ground in a Plot, as ſuppoſe you would incloſe a Field in a Plot with *Yellow*,

with your Pencil take of *Gumbooge* or *Yellow Berries* a very ſmall quantity, and on the inſide of the Black-lead Line draw the Colour along of an equal breadth (as near as you can) from the Line, broader or narrower, according as your Field is in bigneſs, (not dawbing your Field all over with your Colour, as I have ſeen ſome (otherwiſe good things) by this plaſtering way (as I may call it) moſt notoriouſly abuſed.) Then having gone round your Field in this manner with your Colour, wet your Pencil in your Mouth, or have a ſmall quantity of Water by you to dip it in, and ſtrike along the inſide of the coloured Line, bringing it more down towards the Center of the Field: And this will ſweeten your Colours and make it ſhew as if it loſt it ſelf by degrees, to the very colour of your Paper or Parchment. And this courſe is to be taken not only for *Yellows*, but for all other Colours. Then laſtly, with a Pen (if you cannot handle a ſmall Pencil handſomly and evenly) take ſome of that Colour which ſhadoweth that Colour you colour'd your Field with, and go over your Black-lead Line only, ſo ſhall your Field be finiſh'd.

And in this manner may you do a hundred Fields in one Plot, of divers Colours: Only obſerve this, that, as near as you can, you colour not two Fields adjoyning one to the other both of the ſame Colour, but of different: And therefore it will be convenient to underſtand what Colours do ſet one another off beſt, and as near as you can to lay Cloſes adjoyning to one another, of two ſuch Colours, that one Shadow may ſerve both. And thus I conclude this Chapter and this Matter.

CHAP. XIII.

Of Water Levelling, Draining, &c.

I. *How to find whether Water may be conveyed from a Spring-head to any appointed Place.*

THere is an Inſtrument call'd a *Water-Level*, for the Performance hereof, the making whereof is ſufficiently known to moſt that do make Mathematical Inſtruments: They are uſually made about 5 or 6 Foot long, having a Trough cover'd over, or a Copper Pipe to hold the Water, and two Cups, at each End one, into which the Water muſt iſſue to ſet the Level truly. Beſides this Trough, there ought alſo to be two Sights, and another Level for a Plummet, a Staff to ſtand always of an equal Height, and two Station ſtaves with moveable Veins upon them, to move up and down, as ſhall be directed by him that ſtandeth at the *Water-Level*. In this Form, or ſomewhat like this, are *Water-Levels* uſually made. But I have lately ſeen and uſed a Water-level, contriv'd by Mr. *R. Shot-*

Shotgrave, not above 18 Inches long, where the Water (or ſome Spirit to prevent Freezing) is incloſed, with a Tube or Teleſcope underneath the Caſe that holds the Trunk, with a Spring and Screws to bring the Water to its true Poſition. But to ſay no more concerning the Inſtrument and the ſeveral ſorts of them, I will now proceed to ſhew the Uſe thereof.

Water-Levels now a days are generally made with Spirits enclos'd either in a Glaſs Tube or a circular flat Box, cover'd with a Glaſs Cover ground Concave, fix'd to a Teleſcope with Horizontal Hairs, in ſuch manner, that if the Bubble be brought to the Mark of the Glaſs, the Hairs are Horizontal.

Now if it were requir'd to know whether Water may be convey'd in Pipes or Trenches from a Spring-head to any determinate Place, obſerve the following Directions.

Place your Water-level at ſome convenient Diſtance from the Spring head, in a right Line towards the Place to which the Water is to be convey'd; as at 30, 40, 60, or 100 Yards diſtance from the Spring-head. Then have in a readineſs your two Station-ſtaves divided into Feet, Inches, and parts of Inches from the Bottom upwards: Being thus provided, cauſe one (whom you may call your *firſt Aſſiſtant*) to ſet up one of the ſaid Staves at the Spring-head, and require another (which you may call your *ſecond Aſſiſtant*) to erect the other Staff beyond your Inſtrument, at 30, 40, 60, or 100 Yards forward, towards the place to which the Water ſhould be convey'd. Theſe Station-ſtaves being erected perpendicular, and your Water-level about the Mid-way preciſely horizontal, go to the End of the Level, and looking through the Sights, cauſe your *firſt Aſſiſtant* to move a Leaf of Paper up and down your Station-ſtaff, 'till through the Sights you ſee the very Edge thereof; and then, by ſome known Sign or Sound, intimate to him that the Paper is then in its true Poſition: Then let this *firſt Aſſiſtant* note againſt what number of Feet, Inches, and parts of an Inch the Edge of the Paper reſteth, which he muſt note down in a Paper. Then your Water-level remaining immoveable, go to the other End thereof, and looking through the Sights towards your other Station-ſtaff, cauſe your *ſecond Aſſiſtant* to move a Leaf of Paper along the Staff, 'till you ſee the very Edge thereof through the Sighes; and then (by ſome known Sight or Sound) cauſe him to take notice what number of Feet, Inches. and parts of an Inch are cut by the ſaid Paper, which will him alſo to keep in Mind, or note in a Paper, as your *firſt Aſſiſtant* did.

This done, require your *firſt Aſſiſtant* to bring his Station-ſtaff from the Spring-head, and cauſe your *ſecond Aſſiſtant* to take that Staff, and carry it forwards towards the Place to which the Water is to be convey'd, 30, 40, 60, or 100 Yards, and there to erect it perpendicular as before, letting your *firſt Aſſiſtant* ſtand at that Staff where your *ſecond Aſſiſtant* before ſtood: Then in the Mid-way between your two Aſſiſtants, place your Water-level exactly horizontal, and looking through the Sights thereof, cauſe your *firſt Aſſiſtant* to move

a

a Paper up and down, and when you give them a Sign, to note what number of Feet, Inches, and parts of an Inch are cut by the Paper, and note them down. Then going to the other End of your Water-level, look through the Sights, and cauſe your *ſecond Aſſiſtant* to move a Paper along the Staff, and note the Feet, Inches, and parts of an Inch as before.

Then cauſe your *firſt Aſſiſtant* to bring away his Station-ſtaff, and cauſe your *ſecond Aſſiſtant* to take it and carry it 30, 40, 60, or 100 Yards forwarder, towards the Place to which the Water is to be convey'd: And leaving your *firſt Aſſiſtant* at the Place where your *ſecond Aſſiſtant* laſt ſtood, place your Water-level again in the Mid-way between your two Aſſiſtants; and looking through the Sights as before, cauſe each of them to move a Leaf of Paper up and down their Station-ſtaves; and note down in their ſeveral Papers the number of Feet, Inches, and parts of an Inch cut, when you look'd through the Sights of your Water-level.

In this manner you muſt go along from the Spring-head, to the Place unto which you would have the Water convey'd; and if there be never ſo many ſeveral Stations, you muſt, in all of them, obſerve this manner of Work preciſely: So by comparing the Notes of your two Aſſiſtants together, you may eaſily know whether the Water may be convey'd from the Spring-head to the deſir'd Place or not, though there be many Hills between.

¶ Here note, that in your Paſſage between the Spring-head and the appointed Place, from Station to Station, you muſt obſerve this Order, otherwiſe great Error will enſue, *viz.* that your *firſt Aſſiſtant* muſt at every Station ſtand between the Spring-head and your Water-level, and your *ſecond Aſſiſtant* muſt always ſtand between your Water-level and the Place to which the Water is to be convey'd: Thus by obſerving this Order in your Work, you ſhall have no Confuſion, neither ſhall one of your Aſſiſtants take more Pains than the other.

Having thus orderly proceeded from the Spring-head to the Place appointed, call both your Aſſiſtants together, and cauſe them to give in their Notes of the Obſervations at each Station, and add them together ſeverally: Then if the Note of the *ſecond Aſſiſtant* exceed (or be greater than) the Note of the *firſt Aſſiſtant*, take the leſſer out of the greater, and the Remainder will ſhew you how much the appointed Place to which the Water is to be brought is lower than the Spring-head.

The firſt *Aſſiſtant*'s Note.

Station	*Feet*	*Inch*	*Parts.*
1	15	3	1/2
2	2	1	1/4
3	1	6	0
Sum	18	10	3/4

The ſecond *Aſſiſtant*'s Note.

Station	*Feet*	*Inch*	*Parts.*
1	3	2	3/4
2	14	0	1/4
3	3	11	0
Sum	21	2	0

By

By this Table you may perceive that the Notes of the *first Assistant*, collected at his several Stations, being added together, amount to 18 Feet, 10 Inches, and ¾ of an Inch; and the Notes of your *second Assistant* at his several Stations, being added together, amount to 21 Feet and two Inches: So the number of the *first Assistant*'s Observations being taken from the number of the second, there will remain 2 Feet, 3 Inches, and ¼ of an Inch; and so much is the Place to which the Water is to be brought, lower than the Spring-head, according to the straight Water-level, and therefore the Water may easily be convey'd. 'If the Surveyor suspects his Level, 'he may try it thus; on Ground not above 4 or 5 Feet out of the Le-'vel, at any Distance from one another; suppose 10 Chains set upon 'two Staves; and in the Middle of that Distance set up your Level, 'then direct your Level to the *First*, and make your Assistant move 'the Mark upwards and downwards 'till the Hair cut it at A; do 'the like to your other Assistant's Mark (see *Fig.* 39.) 'till the Hair 'have cut it at B.

'*Lastly*, Move your Level to A, and if it cut B, the Hairs are truly 'adjusted; but if not, level your Telescope, and let your Assistant 'at B mark the Division on the Staff, and then move the Signal 'till 'the Hairs cut it, and as much higher or lower than it was before, 'so much is the Error of the Level in 10 Chain's Length; and so 'much must be accordingly allow'd proportionally in all Distances; 'andthese Distances must be measured from every Station of the Level 'to every Staff.

'And tho' the Hairs of the Level be not truly adjusted, yet if it 'be placed exactly in the Middle of the Station-staves, the Errors 'mutually destroy each other

Figure XV.

Having expressed, as plainly as I can in Words, the Manner of conveying of Water from a Spring head to any appointed Place, it will not be amiss to insert a Figure, by the Sight whereof you may plainly perceive how it is effected: In which Figure note, that A represents the Instrument or Water-level, and B the Station-staves; C the Spring-head, and D the Place to which the Water is to be conveyed.

¶ Here note, that when you have call'd your two Assistants together, and examin'd their several Notes, and added them together, if then you shall find the Sum of your *first Assistant*'s Note to be greater than the Sum of your *second Assistant*'s Note, that then it is impossible to bring the Water from that Spring-head to the intended Place: But if the Sums of the Notes of your two Assistants do exactly agree, there is then a Possibility of effecting it, if the Distance be but short, though with more Charge and Difficulty.

'When Water-Levels are made with Telescopes of four or five Foot 'long, then great Distances may be seen very distinct; and in such 'Cases, Allowances may be made for the Curvature of the Earth. 'Which must be as in the following Table.

Distances in Chains.	Allowances in Inches and Parts.
5	,031
10	,124
15	,279
20	,496
25	,772
30	1,116
35	1,519
40	1,984
45	2,511
50	3,088
55	3,751
60	4,464
65	5,239
70	6,076
75	6,948
80	7,936
85	8,959
90	10,044
95	11,191
100	12,400

'Or by the Pen thus; multiply the Square 'of the Chains by 124, and divide the Pro- 'duct by 100000.

'So, if it be requir'd to know what Al- 'lowance must be made when the Level is '40 Chains distant from the Station-staves; 'work thus,

40
40
1600
124
6400
3200
1606

100000) 198400 (1,984

'That is almost two Inches. And in like 'manner, if the Station Staff were distant from 'the Level 80 Chains, or one Mile, the Allow- 'ance is 7 Inches $\frac{9}{10}$.

'And by these Allowances must each Observation be lessen'd in the 'Accounts of both your Assistants. These Rectifications give us the 'true Level; but for the Current of the Water, another Allowance 'must be made, according and proportional to the Velocity requir'd 'in that Current.

'*Lastly*, Observe, that of these three Allowances, that for the Er- 'ror of the Level which is the first, is always proportional to the Sum 'of the Distances; and the second, which is for the Curvature of 'the Earth, is as the Sum of the Squares of the several Distances; 'and the last, which is for the Current is like the first, and is as the 'Sum of the Distances themselves.

¶ Note 2. That the most approved Authors concerning this Particular, do aver, that at every Mile's End, there ought to be allow'd 4½ Inches more than the straight Level for the Current of the Water.

¶ Note 3. If there be any Hill lying in the Way between the Spring-head and the Place to which the Water is to be conveyed, you must then cut a Trench by the Side of the Hill, in which

which you muſt lay your Pipes equal with the ſtraight Water-level, with the former Allowance. And if in this Caſe there be a Valley, you muſt then make a Trunk of ſtrong Wood, well under-propp'd with ſtrong Pieces of Timber, and well pitch'd or leaded, as is done in divers Places between *Ware* and *London*.

¶ Note 4. That in conveying of Water to an appointed Place, it is not convenient to bring it from the Spring head by the neareſt Diſtance, or in a ſtraight Line, but by a crooked or winding Way; and you ought alſo to lay the Pipes one up, and another down: But this is to be obſerv'd but in ſome Caſes only, where the Water will have too violent a Current.

II. *How to take the Level, whereby to convey Water from ſome Pond or Level-Water.*

IT may ſometimes ſo fall out, that you are requir'd to find whether Water may be convey'd from ſome *Pool* or *Level-Water*: To effect which, take two Boards of about two Foot over, or thereabouts, of what Form or Shape, is not material, the larger the better; about the Midſt of each of which Boards bore a Hole, into the which put the Ends of two Sticks, ſetting them up in thoſe Holes perpendiculary: The Sticks muſt be exactly of one Length, and have at the Tops of each of them Marks of white Paper or the like; and the Sticks muſt be of ſuch Length, that when the two Boards, with the Sticks in them, are floating upon the Water, the Marks of Paper at the Tops of them may be ſeen at a competent Diſtance from the Pond. The two Sticks being thus ſeated in the Water, and in a right Line (as near as you can gueſs) towards the Place to which the Water is to be convey'd; then, at as great a Diſtance as you can conveniently, erect a third Stick upon the Land, ſetting a Mark thereupon in an exact Level with the two former which are in the Water; removing the Marks that are either upon thoſe in the Water, or that upon the Land, which you laſt erected, higher or lower (as Occaſion offers it ſelf,) 'till you have brought them all three to a right Level: Then taking exact Notice how high the Marks are above the Top or Surface of the Water, go on with a fourth, a fifth, a ſixth, *&c.* Staff, ſo long as you go in a right Line; for having plac'd two Marks in an exact Level, it is eaſy to find as many more as you pleaſe: And when you are to alter your Courſe, that is, you are to vary from a ſtraight Line, you may then make uſe of your Inſtrument, and proceed in all reſpects, as is before directed: And according as you find the Ground at the Place to which the Water is to be convey'd, either higher or lower than at the Pond, you may determine the Poſſibility or Impoſſibility of its being convey'd thither.

III. *How*

III. *How (without a* Level, *or* Level-water) *to try whether Water may be convey'd from a Spring or Head to a deſigned Place, though at at a conſiderable Diſtance.*

AT the Spring-head begin to make a little Trench, about three or four Pole long, towards the Place which the Water is to be convey'd; whether this Trench be ſtraight or crooked is not material in this Caſe. Then let ſo much Water run as will only fill this Trench, letting none run over at either End of the Trench; but when either End is full up to the Brink, then ſtop the Courſe of the Water. Now, if you find the Trench dry, or ſhallower of Water at that End which is next the Head, than at that End fartheſt from the Head, it declares the Ground to be falling. Then do the like for three or four Pole farther, ſtill making the Water to follow you. And having filled the Trench, ſo that the Water may ſtand level at both Ends thereof, then at both Ends erect two Staves of about four Foot long, at each End of the Trench, being both of equal height from the Surface of the Water. This done, go on in the ſame Line about ten or twelve Pole farther, where ſet up a third Mark, ſo that you ſtanding behind it, and looking to the middlemoſt Mark, you ſee all the Tops, or all the Bottoms, according to which you meaſur'd your equal heights, may all agree. And then, if that ſtick which is below the Mark be longer than the other two, it ſhews a Deſcent; but if it be ſhorter, it ſhews the Ground is higher: But if any riſing Place of Ground be in the way, you may eaſily find the height of its riſe by ſetting up a Stick, and meaſuring it, as before is ſhew'd.

IV. *To know how high you may ſet your Cock in your Houſe, when Water is convey'd thither.*

WHen you have brought the Water from any Head or Spring to your Houſe, and would know how high you may place your Cock, begin at the Conduit-head, and dig a Trench near a Foot deep; but as you go farther off, let it be ſtill ſhallower, for 5 or 6 Pole in length, more or leſs according to the fall of the Ground, ſo that the Water may but juſt follow you; and when it begins to run over, there ſtop it, and begin a new depth as before: But be ſure, let the Fall of the Water be down-right, like the Steps of a Pair of Stairs: And in this manner go on, 'till you come to the Place to which you intended to bring it. Having thus done, add

the

the Fall at the Conduit, and the Depth of your ſeveral Stairs together: And ſo high in your Houſe above the Level of the Trench may you ſet your Cock.

V. *Concerning the Cleanſing of Water.*

IF the Water which comes to your Houſe be noiſome, you may thus purify it. Make a Trench from your Houſe about three or four Perches long or more, (for the longer it is the better,) and a Foot and half deep: Fill this Trench a Foot thick from the Bottom with Hurlock or Clunch cut in Pieces (as fit for the Lime-Kiln:) Then fill it one Handful higher with Pebble-ſtones; then fill it up with Gravel or Earth; the Water running through it will be ſo purified, that it will be fit for Brewing, for the Pot, Waſhing, or any thing elſe.

This alſo greatly mendeth Well or Pump-water: For the Well being cleanſed from Mud, and Clunch put therein almoſt as high as the Water riſeth, it will mightily mend the Water.

VI. *Concerning Flowing of Grounds.*

TO deſcribe the manner of making of *Mills*, to go either with the *Wind*, *Water*, or other Force, or *Sluces*, or other *Engines* for the *mounting* of *Water*, is not my Deſign in this Place; but to deliver ſuch plain Rules and Directions to any Gentlemen or others, who occupy or poſſeſs Grounds; how, when Occaſion requires, they may *flow* them; it being of good Uſe in a dry Seaſon: For by this Means ſome one Man by *flowing* of his Ground, having a River adjoyning, hath made his Ground yield him 5 *l.* an Acre, whereas his Neighbour hath ſcarce made 20 Shillings an Acre of his, although, at other Seaſons, the one Man hath made his worth as much an Acre as the other, the Grounds being naturally of an equal Goodneſs.

Having by *Drains* and *Dams* brought the Water to the higheſt Part of that Ground which you would flow, you muſt cut a little *Trench* as level as you can gueſs (having no Inſtrument) by your Eye, which Trench let be about nine Inches broad, and ſeven or eight deep, and about fifteen or ſixteen Foot in length at the firſt, laying the *Turfs* which you cut out cloſe to the Trench, on the lower ſide thereof, with the Graſs-ſide downwards. This done, let the Water into this Trench, allowing it to run over a little at the lower End thereof: And thus may you ſtop the Water with a *Turf*, and cauſe the Water to run over in any Part of the Trench.

Now, in the making of this Trench, if you find that the Water will not follow you, you muſt with a Spade, made crooked at the End, ſink it deeper, and caſt out the Earth, and in your going on, go deeper and deeper, as you ſhall find Occaſion, yet not deeper than that the Water may juſt follow you; thus proceeding 'till you come to the farther ſide of the Ground. And in your Paſſage, according as you find the Ground to fall, you may make croſs Trenches, of about four or five Pole one from the other, the ſame Way as formerly is ſaid, 'till you have made Drains enough.

In caſe you are to carry your Water over ſome Ditch, Brook or Valley, you muſt then make a Boat of Boards nailed together, making a Trough thereof, through which the Water may run.

VII. *Of Draining of Grounds.*

THis is more eaſy and with leſs Charges performed then *Floating*, and is altogether as neceſſary, and as advantageous as *Floating* is, and that not only in *Arable*, but in *Meadows* which lie low, in *Woods*, *Bills* and *Boggs* upon Hills.

The Inſtruments neceſſary for this purpoſe are, a *Plow*, *Spades*, *Scoops*, *Shovels*, and *Forks*.

The *Plow* makes the Way, and the *Spades*, *Scoops*, *Shovels*, *Bills*, &c. are uſed by thoſe which follow the *Plow*, in clearing of the Way which the *Plow* hath made, from *Turfs* and other Obſtacles which fall in after the *Plow*, as *Roots*, *Stones*, and ſeveral the like. This Inſtrument (I mean the *Plow*) is ſo neceſſary, that (ſaith my Author) in ſome Pariſhes they maintain a Town-Plow, that will hold eight or nine Yoke of Oxen, and two Horſes for Boys to ride on to guide the *Plow*, while others (booted up to the Middle) hold the *Plow*: And with theſe *Plows* much good hath been done in hard and ſtoney Grounds, and alſo in the throwing out of Ditches which have been ſtopp'd, and in making good of High-ways, as alſo in Clay-grounds, and ſuch like; and thus (ſaith the ſame * Author) they do ſerve their *Peaſe-ſtubble*, *Barley-ſtubble*, and *Low Meadows*, eſpecially their *Commons* once a Year, and that about *All-Saints* Day. And for the making of any new *Drain*, *Ditch* for Quickſets, *Brook* or *River*, he giveth this Direction. Firſt, 'Set 'up your *Mark* or *Marks* at the End of each nine or ten Poles, on 'both ſides of the Riders, to guide the Horſes by: Then plough 'once all over that Breadth, and throw out the Earth; then ſet 'the Horſes ſingle, and with any other lighter *Plow*, plough again, 'and throw out as before, 'till you are deep enough. And by this 'means (ſaith he) more may be diſpatch'd in one Hour, than in

* Mr. *George Atwell* of *Cambridge*, an Experienced Man both in Art and Husbandry, from whom I receiv'd ſeveral ſuch like Directions concerning Grounds.

three

'three Days otherwiſe. And alſo, that many great Works, for 'many Years deem'd impoſſible, have been in ſhort Time brought 'to great Perfection, to the great Profit of the Owners, the ſa-'ving of Cattle, and eaſe of Travellers. And moreover, he ſaith, 'in theſe Words: 'I have known divers *High-ways*, where one 'Furlong hath abutted upon them, and another run long-wiſe 'by the ſide of it, where the Way hath not been above a Pole 'broad, that the *Plow* continually carrying out of Mold upon 'it, hath ſo raiſed that Linſy-ſide, that it hath been ſo Linſy, that 'not a loaden Cart hath gone on it in Harveſt, or Hay-time, 'ſince the Memory of Man, yet the moſt neceſſary Harveſt-way: 'This (ſaith he) have I mended and made level with my own '*Plow*, and my own People, in two Hours, a quarter of a Mile 'together: And the like have I done to raiſe a Road-way in the 'Middle, by ploughing and throwing up both ſides.

And thus you have the Way how to *Drain* ſuch Grounds wherein the Uſe of the *Plow* is required: I ſhall now ſhew how to *drain* ſuch Grounds where the *Spade* is the principal *Inſtrument*, which may be called.

Water-Furrowing.

When any *Grain* whatſoever is new *Sown*, preſently *Water-furrow* by *Plow* and *Spade*, (as the Ground requires.) For if it ſo fall out, that (in a Flood) the Water goes not away ſo faſt as it comes, (although in two or three Days it will be clean gone,) yet you are never the nearer, it hath done (already) what Hurt it can, your *Grain* is drowned, and the Fault is in the main Drains, yet not their Depths, (for they will be dry in two or three Days,) but in their Breadths. Wherefore, if you are to make a new Drain, you may do it with the *Plow*, as before; but only to deepen or to widen old ones, the *Spade* is beſt. But many times Drains are ſtopp'd by ſeveral Accidents, as at Places where Cattel go over, which may be remedied by making a Bridge of Splinters of Timber with Bavens and Gravel over them.

VIII. *Concerning Bogs and Quagmires.*

THeſe do iſſue (for the moſt part) of *Spewing Springs* that are in a Vein of *Gravel*, moſt commonly near the Superficies of the Ground, and ſtill drawn more upwards by the Heat of the Sun: Or elſe they are in ſuch places which formerly have been all Water, (as the *Fens* ſometimes have been,) and ſo growing of Weeds at firſt, they rotting have turn'd to Earth, and ſo in proceſs of Time have ſwoln up to a great Height.

Now

Now if your *Bog* be ſo tender that you cannot go upon it, then at the upper Part (where it firſt riſeth) make a large and deep *Ditch*, ſo deep that it may be lower than the Bottom of the *Springs* by a Foot or two: This Water convey ſo, that none of it may ſtand in the Ditch; ſo that the Water of the *Springs* may be cut off. Then make a leſſer Ditch round about, and when it hath drain'd thus a while, that you can go upon it, dig Drains up the Hill, as deep as you can, and about twenty Foot from each other: And by this means (in a ſhort time) you may have good Ground either for *Orchard*, *Hops*, or *Paſture*.

The End of the Second Part of the Fourth Book.

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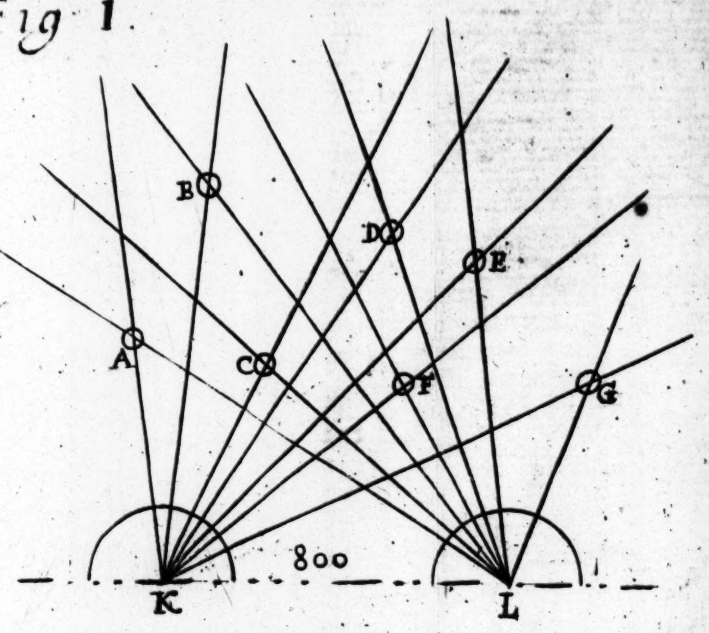

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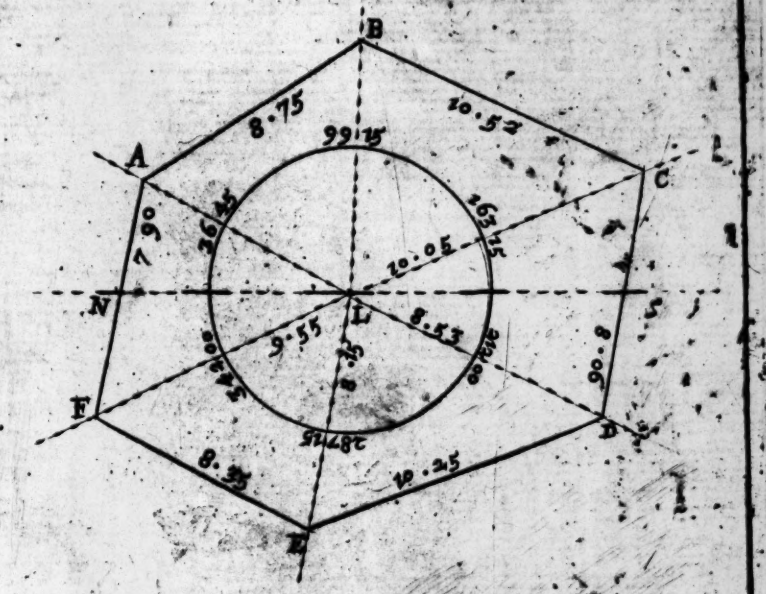

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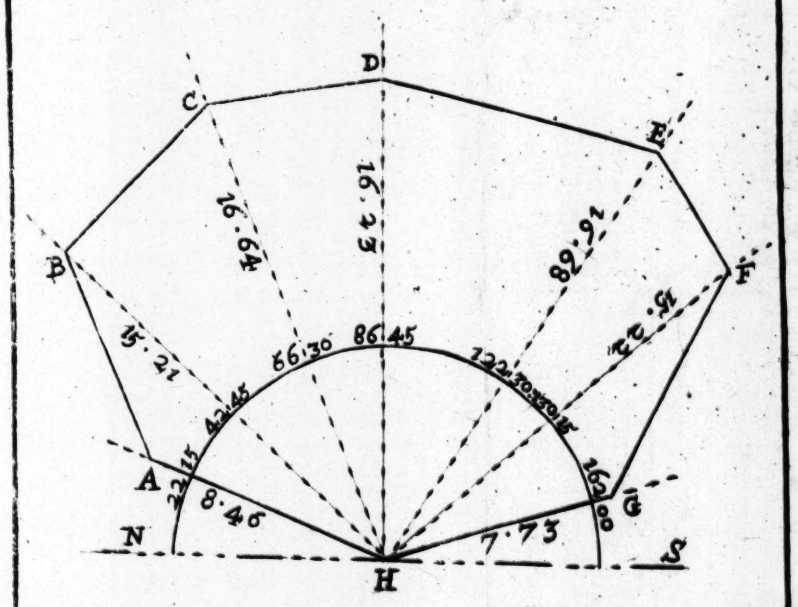

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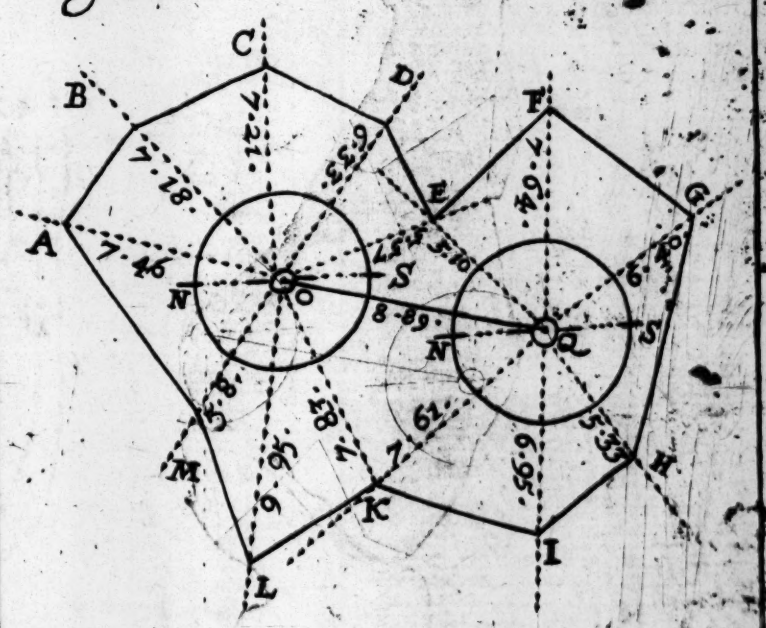

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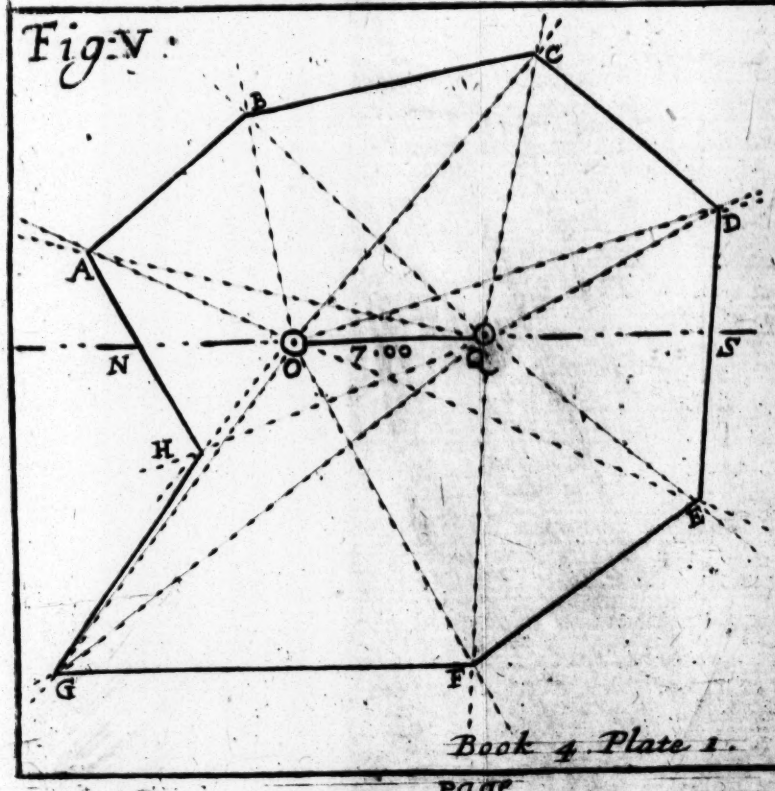

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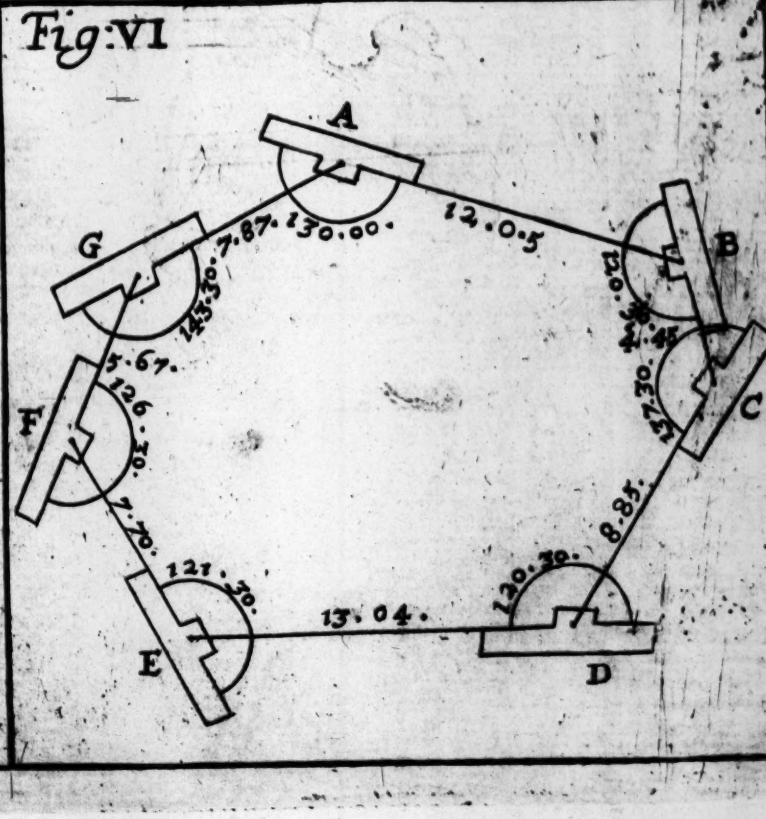

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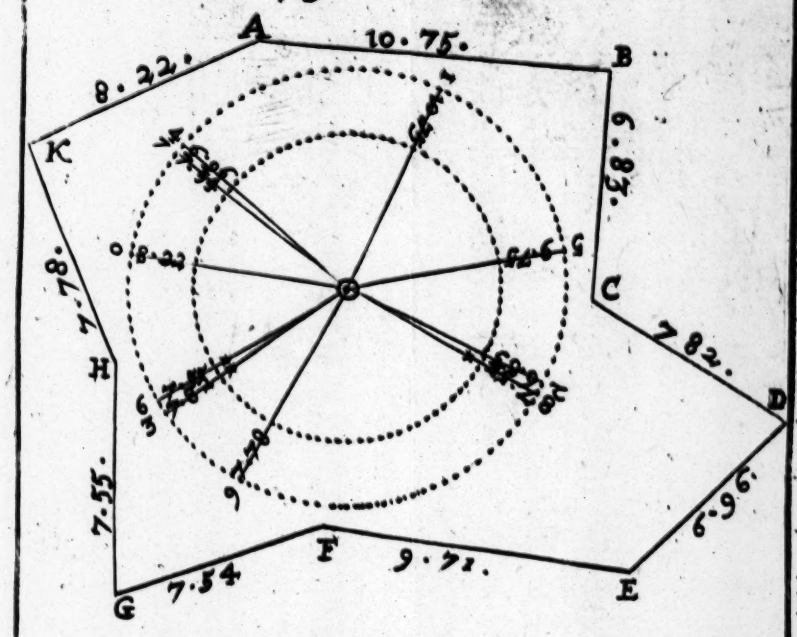
Fig: VII



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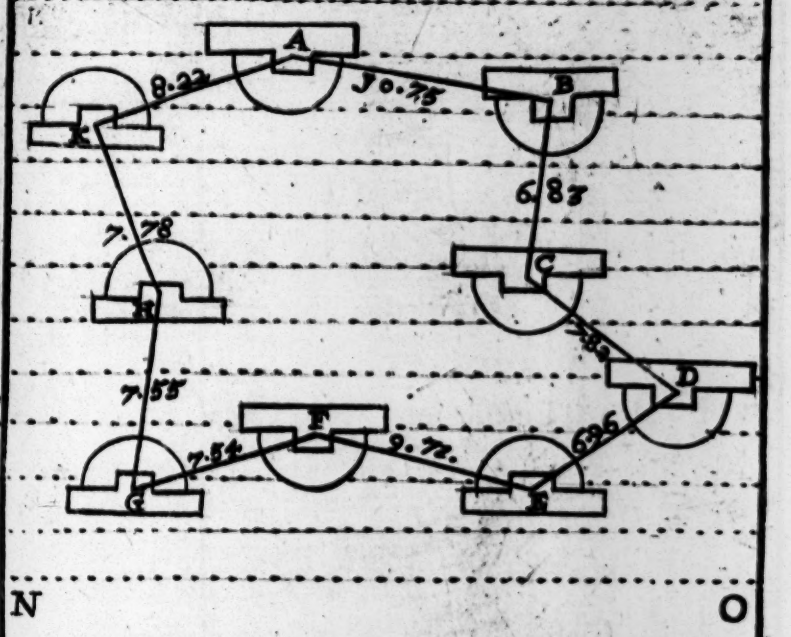

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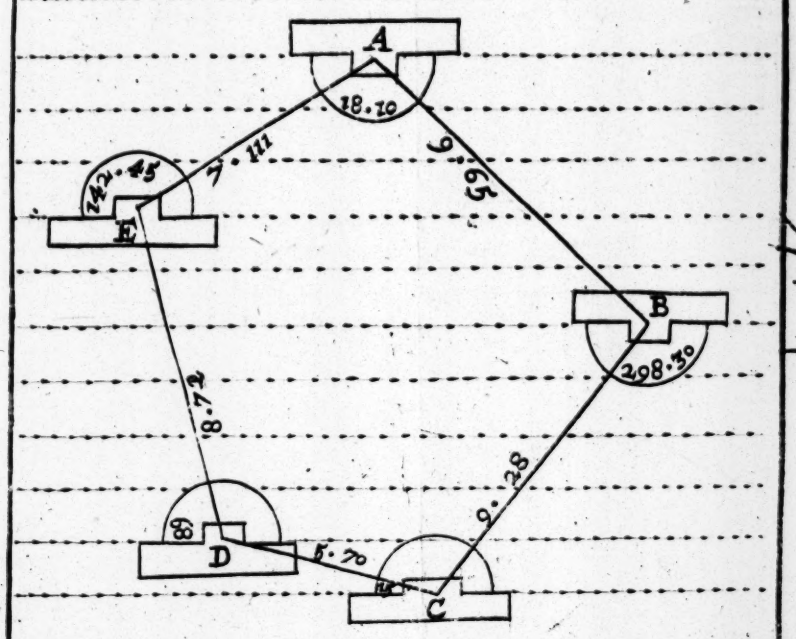

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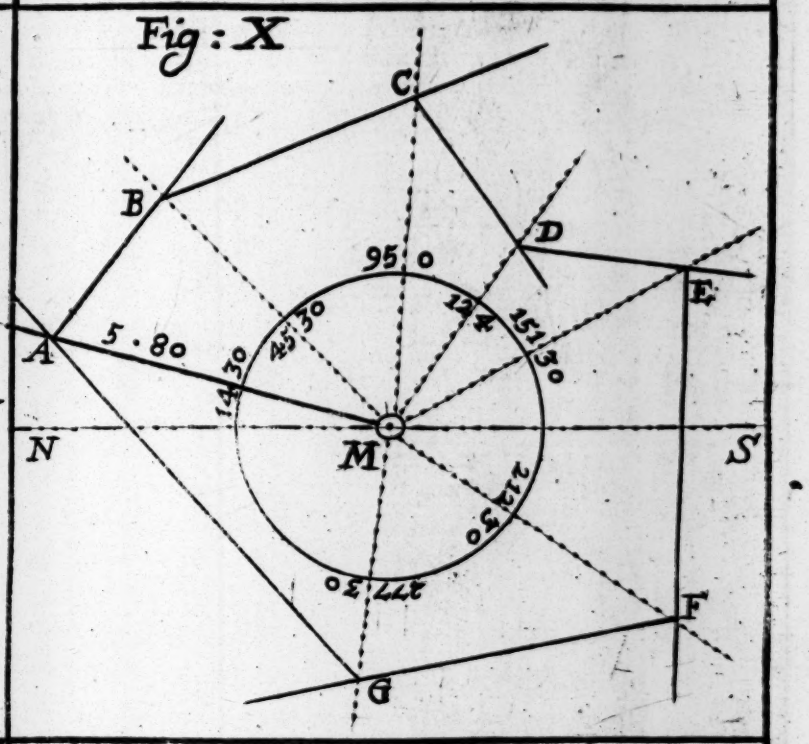

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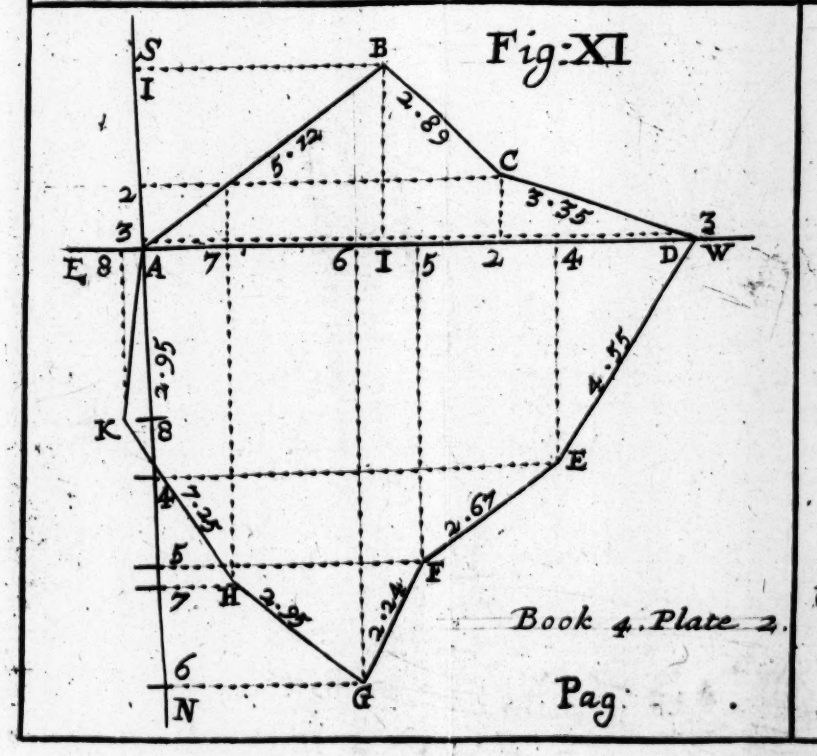

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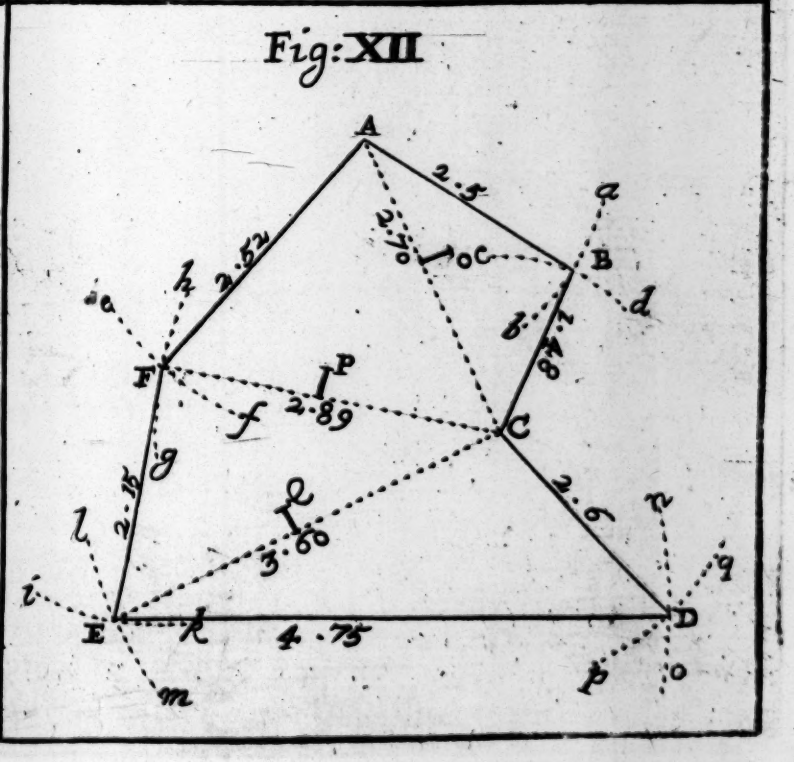

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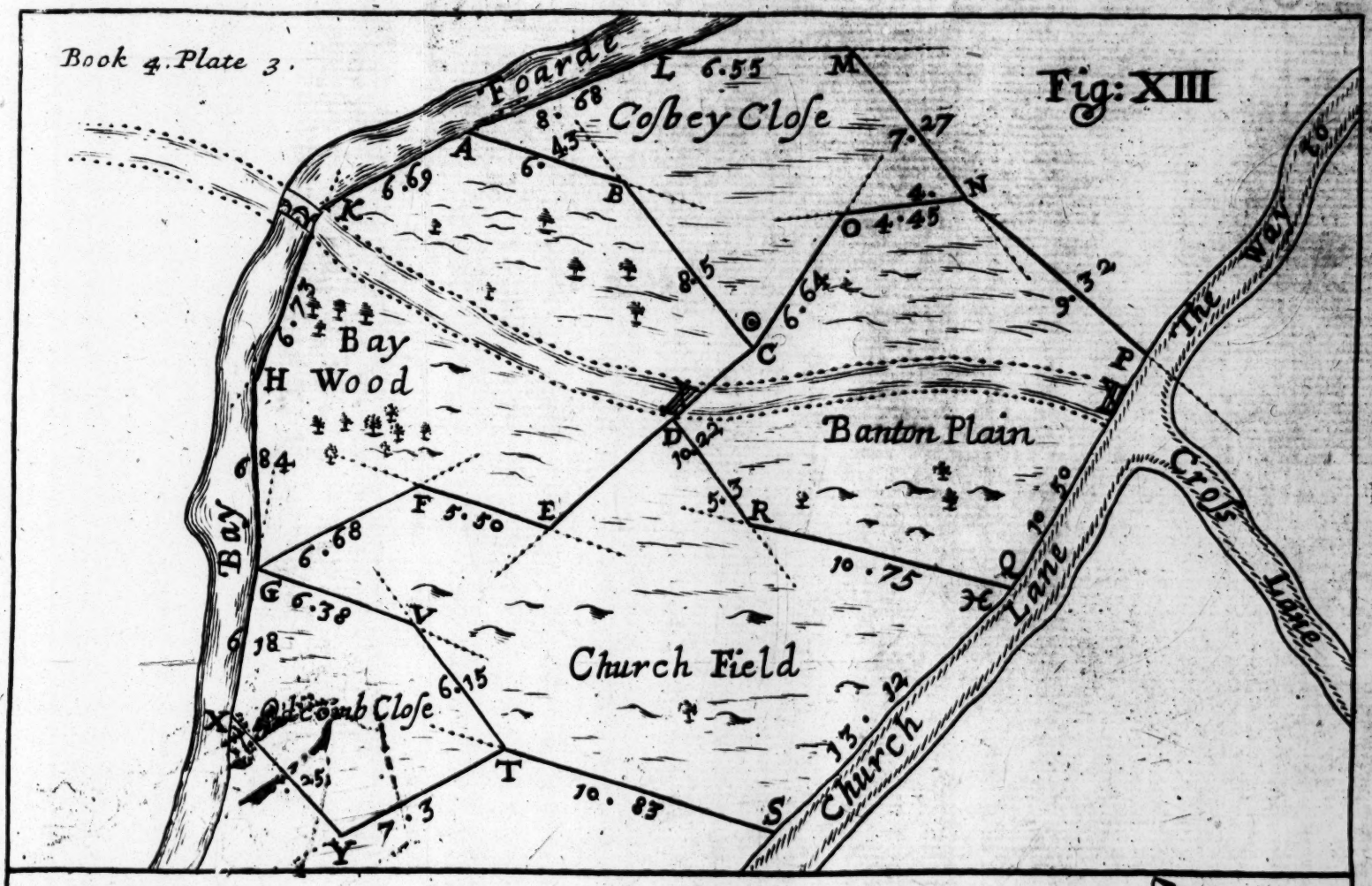

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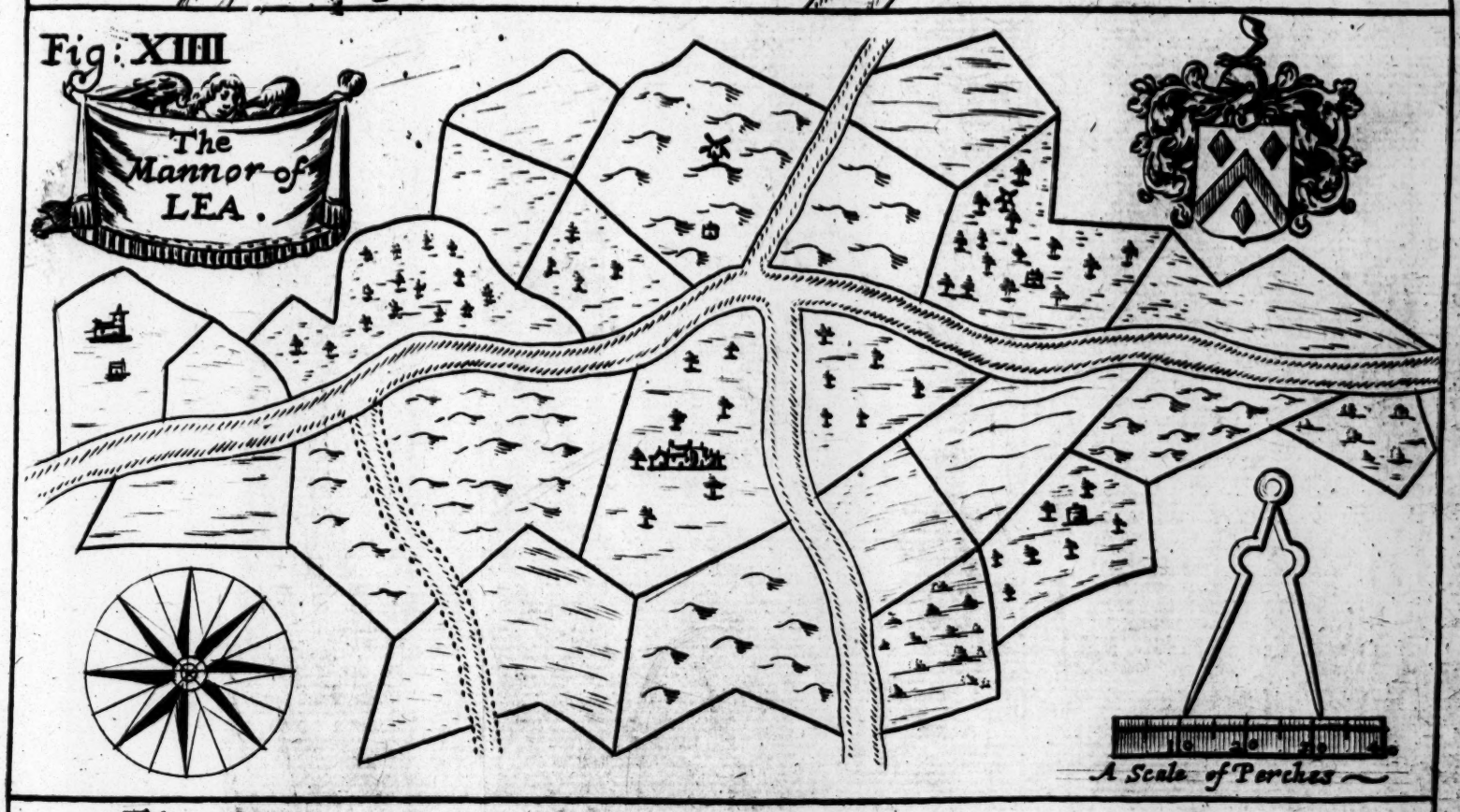

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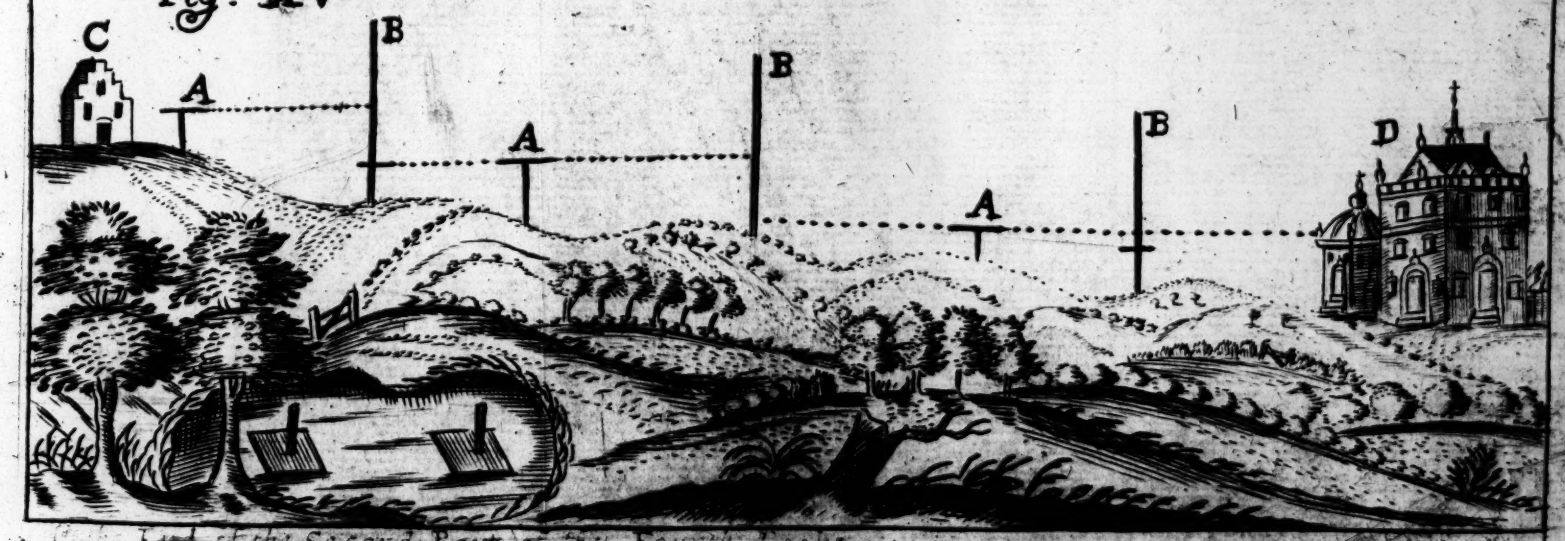

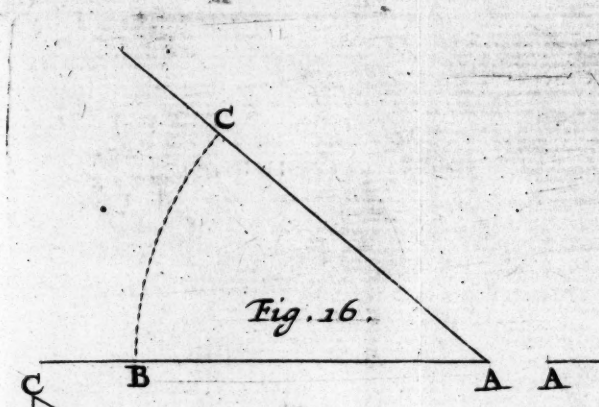

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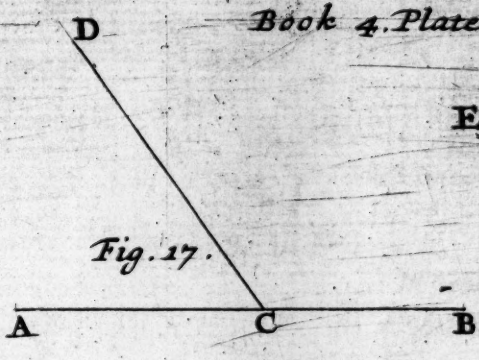

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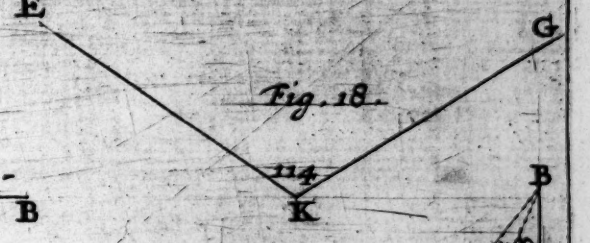

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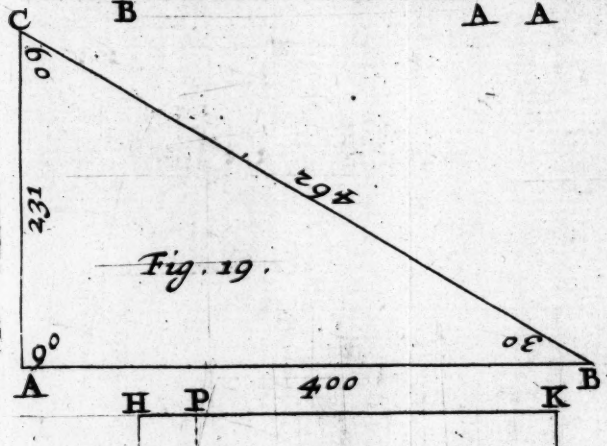

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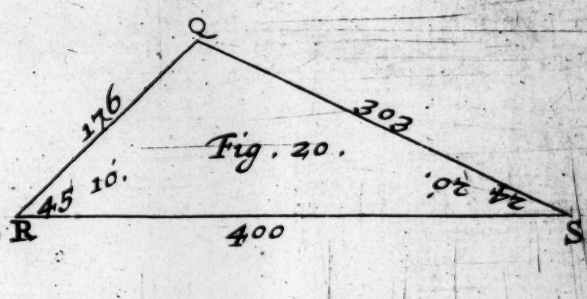

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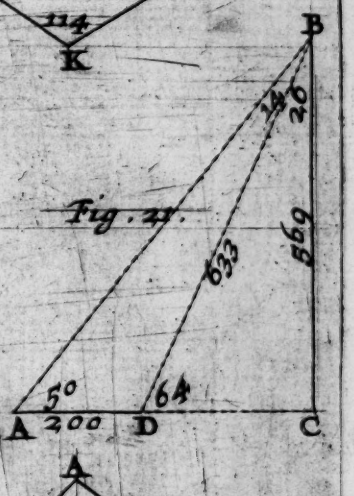

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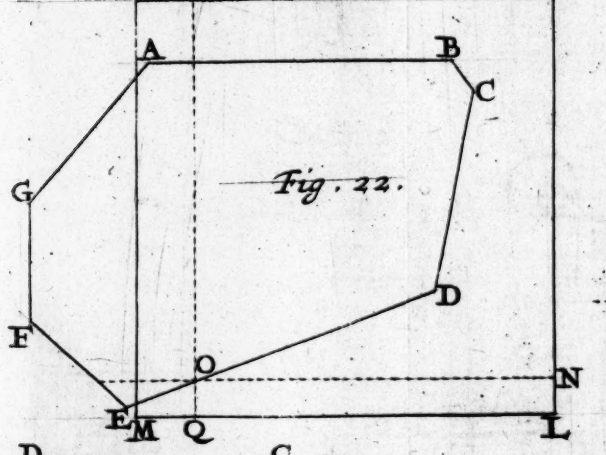

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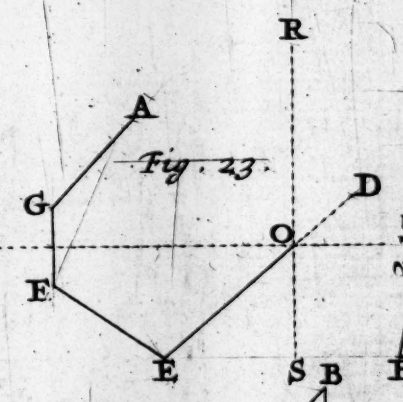

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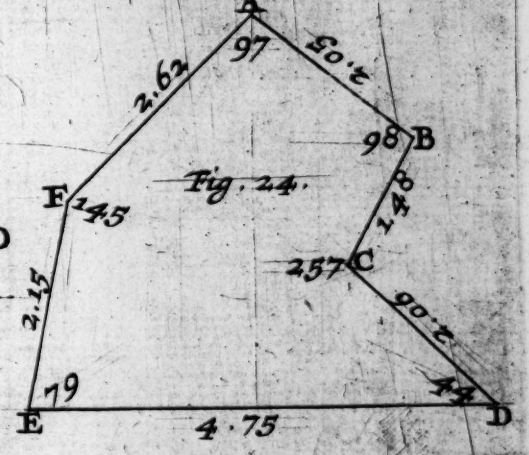

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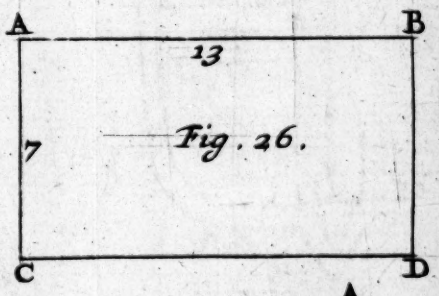

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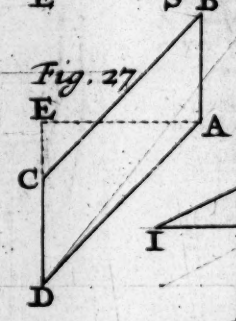

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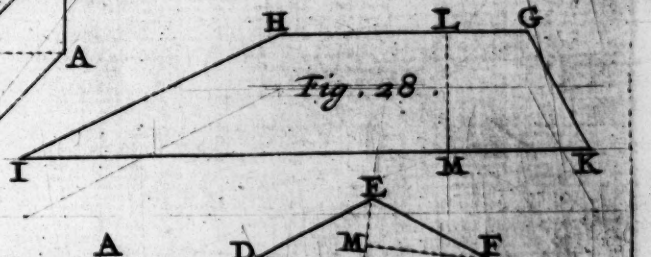

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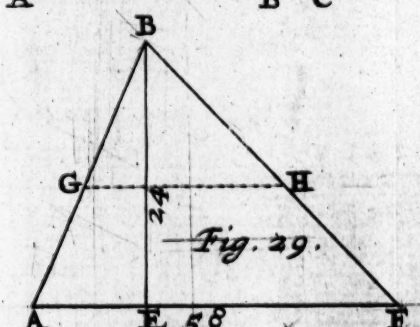

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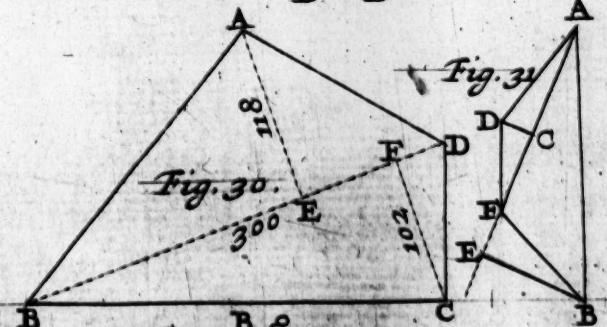

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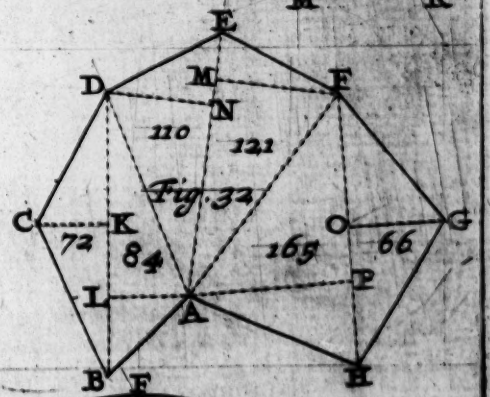

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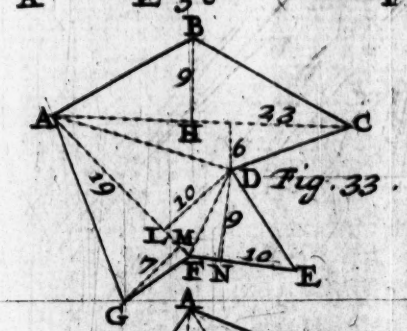

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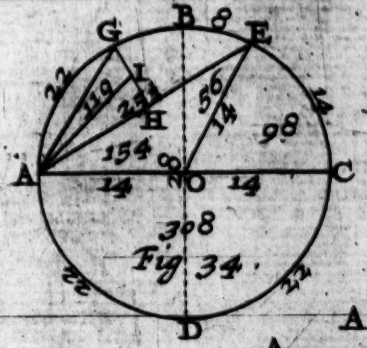

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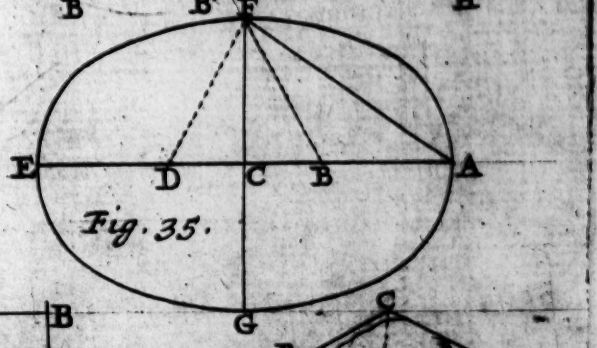

Fig. 35.

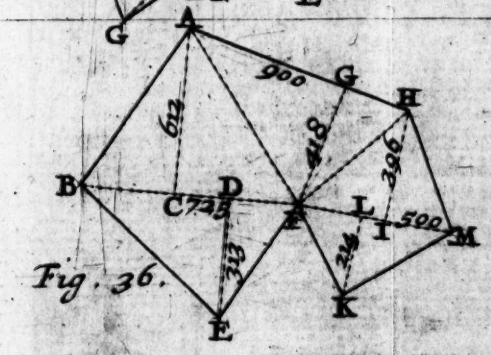

Fig. 36.

Fig. 37.

Fig. 39.

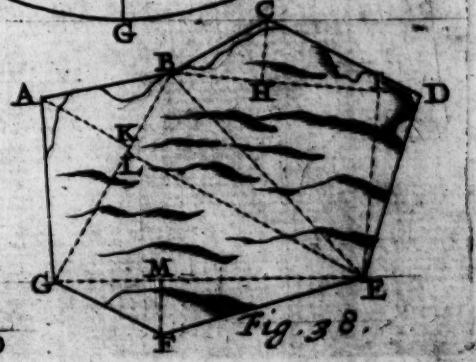

Fig. 38.

THE

COMPLEAT SURVEYOR:

SHEWING

How to take *Heights*, *Distances*, and to *Survey* all manner of *Land by*

A SEMI-CIRCLE.

Which (to distinguish it from the *THEODOLITE*, *CIRCUMFERENTOR*, *PERACTOR*, or other graduated *Instrument*:) I call,

The Perambulator.

The Fifth BOOK.

A Description *and* Figure *of the* INSTRUMENT.

THE *Instrument* (*Fig.* 1.) is no other than a *Semicircle*, and may be made in Brass or Wood, of what Largeness you please: In *Brass* (which is best) the Diameter thereof may be about Fifteen or Sixteen Inches: In Wood Larger.

The outermost *Limb* of the *Semicircle* is divided into 180 Degrees, which are number'd by 10, 20, 30, *&c.* (from the left Hand towards the Right,) to 180 Deg. at B: And again (beginning at the same Place, and the same way) from 180 to 360 Degrees at B also.

Then, in another Circle under these, the two Quadrants are divided each into 90 Degrees, beginning at S, and number'd from thence, both ways, by 10, 20, 30, *&c.* to 90 at E and W: And

under these two Quadrants, is engraven in one of them *South-East*, and in the other *South-West*: For the Letters E, S, N and W, signify *East*, *South*, *North* and *West*, and your *Instrument* (when you use it,) must have respect to those *Quarters* or Parts of the *Heavens*.

In the middle Bar of the *Semicircle*, S, N, (which is of Breadth sufficient) let there be plac'd a long *Box* of *Brass*, wherein to hang a *Needle*, with a *Glass* over it, which may be so order'd, to lie under the *Semicircle*, that the *Index* with its *Sights*, may freely move over it.

Then upon the *Diameter*, at D and F, and also upon the *Index* at G and H, let there be *Doughtales* sawder'd, to slide Sights upon; and so is your *Instrument* finish'd, as to the *Superficies* thereof; all which the *Figure* of it, will demonstrate to your View better than many Words.

See the Figure.

On the Backside of the *Instrument* there is to be screw'd a small *Socket*, into which goeth another *Socket*, call'd a *Ball-Socket*, which serveth to set the *Instrument*, when it is upon the *Staff* in any Position whatever, as *Horizontal* or *Level* (which it ought always to do in *Surveying* of *Plain Grounds*) *Vertical* or *Perpendicular*, (when in taking of *Altitudes*.)

Into the *Ball-Socket* there goes the *Head* of a *Staff* with *three Legs*, upon which the *Instrument* with all its Parts resteth.

Thus much concerning the *Instrument*; and for the *Protractor*, (whereby to lay down any thing taken or Surveyed) let it be *divided*, *number'd*, and *noted* with the same *Letters* as the *Instrument* itself is *divided* and *figured*.

The Use of the Instrument.

I. *In taking of* Altitudes *and* Distances, *either* Accessible *or* Inaccessible.

Prop. I.

How to take the Height *of a* Tree, Tower, Steeple, *or other* Object, *being* Accessible.

Let A B, (*Fig.* 2.) be a Castle Wall, and you standing at C, would know the Height thereof.

Place your Instrument (it being upon its Staff well fixed) at C, and direct it to the Object, and hanging a Line and Plummet upon the Centre of the Instrument; move the Instrument up and down (by help of the *Ball-Socket* only) 'till the Thread and Plummet hang directly upon the Line N S, and then, looking through the two

two Sights which are upon the Diameter of the Instrument, mark what Part of the *Castle Wall* you see; for that Part is in the just *Level* with your Eye, which Point will be at B —— Then move the Instrument upwards or downwards, 'till (through the same Sights) you see the very Top of the *Castle Wall* at A: Then (the Instrument there resting) look what number of Degrees and Minutes are cut by the Thread; we will suppose them 35 Degr. which note down: And then measure with your Chain; (a Foot Chain is fittest for these Conclusions) the Distance from F to B, or from C to D, the Foot of the Castle, which we will suppose to be 205 Foot: And by the help of these two, the *Height* required may be found, as followeth.

1. *By Protraction.*

Upon a Sheet of *Paper*, or the like, draw a right Line at pleasure, as *m n*, towards one End whereof, as at B, erect a Perpendicular B A, representing the *Castle Wall*: Then from any *Scale*, take 205 Foot, your measured Distance, and set it from B to F.

This done, upon the Point F, protract an Angle of 35 Deg. (which were the Degrees cut by the Thread) and through that Point draw a right Line, as F A, 'till it cut the Line A B, representing the Castle Wall in the Point A: So shall the Length of the Line A B, be the Height of the Wall required: Which measured by the same Scale will be found to be 143.5 Foot, to which add B D 5 Foot, the Height of the Instrument above the Ground, and you'll have 148.5, and so high is the *Castle Wall*.

2. *By Calculation.*

This Work might have been done without Protraction, by the *Second Case* of right Angled Plain Triangles, as in *Book* 3. *Chap.* 4. *Case* 2. hereof,

In this Manner;

As the Co-Sine of 35 Degrees the Angle cut by the Thread,	9.91336
Is to the measured Distance F B 205 Foot,	2.31175
So is the Sine of the Degrees cut by the Thread 35^d	9.75859
	12.07034
To the Height required A B, 143.5 Foot,	2.15698

PROP.

PROP. II.

How to take an Inacceſſible Altitude.

SUppoſe A B (*Fig.* 2.) to be the *Wall* of a *Fort* or *Caſtle*, and that you can come no nearer to the Bottom of the *Wall*, than to G, for that there is a *Ditch* or *Moat* about the *Caſtle* of that Breadth.

Firſt, Place your Inſtrument at G, the Brow of the Moat, and directing the Sights to A, the Top of the Wall, you'll find the Degrees cut by the Thread and Plummet, to be 60 Deg. 52 Min.

Secondly, Go backwards a competent Diſtance of Ground in a right Line, as to to F 125 Foot, and there placing your *Inſtrument* as before, direct the Sights to A, where you find the Thread to cut 35 Deg.

By the help of this *Diſtance*, and the other two obſerv'd *Altitudes*, the *Height* of the *Wall* A B may be attained, as followeth.

1. *By Protraction.*

Firſt, Draw a Line at pleaſure, as *m n*, upon which, towards one End thereof (as at F) with a Scale of *Chords*, or your *Protractor*, lay down an Angle of 35 Deg. the ſame as were cut by the Thread and Plummet when the *Inſtrument* ſtood at F, and draw the Line F A.

Secondly, Your *meaſured Diſtance* being 125 Foot, take 125 out of your Scale, and ſet them from F, forwarder, to G.

Thirdly, Upon the Point G, protract an Angle of 60 Deg. 52 Min. the ſame which the Thread and Plummet did cut, when you ſtood at G: And draw the Line G A, croſſing the former Line F A, in the Point A.

Laſtly, From the Point A, let fall a *Perpendicular* upon the Line *m n*, and it will fall upon the Point B. So is A B the *Height* of the *Caſtle Wall* required: Which, if you meaſure upon your *Scale*, you will find to contain 143.5, that is 143 Foot and a half.

2. *By Calculation.*

As by the VII^th^ and III^d^ *Caſes* of right Lines Triangles: Thus,

In the oblique angled Triangle A G F, you have given, (1.) The Angle A F G, obſerv'd when you ſtood at F 35°. (2.) The Angle A G F, 119 D. 8 M. the Complement of 60 D. 52 M. (as you obſerv'd when you ſtood at G) to 180 Deg. And (3.) The *meaſured Diſtance* between G and F 125 Foot. And having the Angles at F and G, you have the Angle G A F alſo given. Then ſay,

ſay, as the Sine of G A F, 25 Deg. 52 M.——	9.63976
Is to the meaſured Diſtance 125 Foot, ——	2.09691
So is the Sine of A F G, 35 Deg.——	9.75859
	11.85550
To the Side A G, 164.34 Foot, ——	2.21574

Then ſay again,

As the Sine of 90 Deg. ——	10.
Is to the Side A G, 164.34 Foot,——	2.21574
So is the Sine of the Angle A G B 60 Deg. 52 Min	9.94126
To the Sine A B 143.5 Foot,——	×2.15700

To which add five Foot, the Height of the Inſtrument above the Ground, and you have 148.5 Foot, the Height of the Caſtle.

PROP. III.

How to take an Inacceſſible Diſtance, *at two Stations remote from the* Place *whoſe* Diſtance *is required.*

SUppoſe you were to ſtand in a *Field* at C, (*Fig.* 3.) and that it were requir'd of you to know, how far diſtant the *Tree* at A is from you; between which *Tree* and the Place of your ſtanding at C, there is a *River*, as D, ſo that you cannot come near the *Tree*.

Firſt, Place your *Inſtrument* at C, and turn it about upon the *Staff*, 'till through the *Sights* which are upon the *Diameter* thereof, you ſee the *Tree* at A, and there ſcrew it faſt.

Secondly, At ſome convenient Diſtance from C, let a *Mark* or *Beacon* be ſet up; as at B, diſtant from C 110 Foot: (or other Meaſure.)

Thirdly, Turn the *Index* of your *Inſtrument* about, 'till, through the *Sights* thereon, you ſee the *Mark* ſet up at B, noting the Degrees cut thereby, which, let us ſuppoſe to be 110 Deg.

Fourthly, Remove your *Inſtrument* from C to B (ſetting up a *Mark* at C, where the *Inſtrument* before ſtood) and turn it about, 'till through the *Sights* which are upon the *Diameter* thereof, you ſee the *Mark* at C, and there fix it: Then turn the *Index* about, 'till through the *Sights* thereon, you ſee the *Tree* at A, and note what Degrees the *Index* cutteth: Which we here ſuppoſe to be 40 Deg. And now, by help of theſe two *Obſervations*, and the *Diſtance* btween C and B; the Diſtance to the *Tree* at A, may be found.

1. *By Protraction.*

Upon *Paper* (or the like) draw a right Line at pleaſure, as the Line *v w*. Then upon any Part thereof, as on the Point C, which repre-

repreſents your *firſt Station*, protract an Angle of 110 Deg. and from C, through that Point draw a Line at pleaſure, as the Line C *x*, upon which Line, ſet your *meaſured Diſtance* 120 Foot, from C to B, the Point of your *ſecond Station*. Upon which Point B, protract an Angle of 40 Deg. (the ſame which your *Index* cut at your *ſecond Station*) and through that Point, from B, draw a right Line at pleaſure, as B *s*, cutting the Line *v w* firſt drawn, in the Point A, which is the *Point* repreſenting the Place where the *Tree* ſtands: And therefore, if you take the Lines C A and B A (ſeverally) in your *Compaſſes*, and *meaſure* them upon the ſame *Scale*, from whence you took your *meaſured Diſtance* C B, you will find, that C A will contain 145.5 Foot; and B A 224.5 Foot; and ſo far is the *Tree* at A, diſtant from B or C.

2. *By Calculation.*

The three Points A, B, C, do make an *oblique angled Triangle*; in which there is given, (1.) The *Angle* A C B, obſerved at your *firſt Station*, to be 110 Deg. (2.) The *Side* C B, your *meaſured Diſtance* 120 Foot. (3.) The *Angle* A B C, obſerv'd at your *ſecond Station* to be 40 Deg. And (4.) The *Angle* C A B 30 Deg. For the *Angle* at C being 110 Deg. and the *Angle* at B 40 Deg. their Sum 150 Deg. ſubſtracted from 180 Deg. leaves 30 Deg. for the *Angle* at A, and then the *Proportion* is,

As the Sine of the Angle B A C, 30 Deg.	9.69897
Is to the Diſtance C B 120 Foot,	2.07918
So is the Sine of the Angle A B C 40 Deg.	9.93753
	12.01671
To the Diſtance C A, 207.8 Foot,	2.31774

For the Diſtance from C to A:

And ſo the Sine of 110 (70 Deg.) the Angle B C A, to the Diſtance B A, 225.5 Foot.

PROP. IV.

How to take the Diſtances *of ſeveral* Places *remote from you; and alſo, of the ſeveral* Diſtances *of thoſe* Places *one from another.*

LET A B C D E F G H I K, (*Fig.* 4.) be ſeveral Places remote from you, as *Churches*, *Halls*, &c. in a *Town* or *City*; or other like *Objects*.

Firſt, Make choice of two *Places*, from either of which you may ſee all the *Objects* or *Places*, whoſe *Diſtances* from each other you deſire to know, which two *Places* let be S and N, diſtant from each other 1000 *Paces*, or other Meaſure.

Second.

Secondly, Set up your *Instrument* at S (which call your *first Station*) and direct the back *Sights* that are upon the *Diameter* to N, (which call your *second Station*) and then *screw* it fast: Then,

Thirdly, Turn the *Index* about, 'till through the *Sights* thereof, you see the first *Object* at A; and note what Degrees the *Index* cutteth, as in this *Example* it doth cut 23 Deg. 30 Min. which note down:

	First Station at S		Sec. Station at N	
	Deg.	Mi	Deg.	Mi
A	23	30	12	45
B	48	45	19	30
C	78	15	40	45
D	97	30	62	30
E	139	00	84	30
F	152	45	121	30
G	200	00	221	00
H	225	15	279	15
I	229	0	287	30
K	284	20	325	30

Stat. Dist. 1000 Pac.

And move the *Index* about till through the *Sights*, you see your *second Object* at B, where the Index cuts 48 Deg. 45 Min. which set down also. Do the like to all the rest of the *Objects* at C, D, E, F, G, H, I and K, noting the Degrees which the *Index* cuts at every *Object*, and you'll find them to be such as in the Margin under [*first Station* at S.]

Fourthly, Remove the *Instrument* to your *second Station* at N, and from thence look through the *Sights* on the *Diameter*, 'till you see your *first Station* at S, and then *screw* it fast: Then,

Fifthly, Turn your *Index* about, 'till thro' the *Sights* you see your *first Object* at A, and see what Degrees are cut by the *Index*, which in this Example are 12 Deg. 45 Min. which set down as you see them in the Margin under *second Station* at N: And thus directing the *Sights* to all the *Objects* B, C, D, E, F, G, H, I and K; you will find the several *Degrees* cut by the *Index* to be such as are set down in the *Table* in the *Margin*, under [*second Station* at N.] And now,

Lastly, By help of the *Stationary Distance*, and these *Angles* taken at both the *Stations*, S and N, you may make a perfect *Plot* or *Map* upon *Paper* or *Vellom*, of all those *Places* with their true *Positions* and *Distances* one from another, as you may see done in this *Figure*: In this manner,

1. *By Protraction.*

Being provided of a large Sheet of *Paper*, or Skin of *Vellom* or *Parchment*.

First, Draw a Line thereupon, to contain 1000 *Paces*, taken from any *Scale*, as the Line S N, representing the *South* and *North Points*.

Secondly, Place the Centre of your *Protractor* upon the Point S, and the Diameter thereof upon the *Station* Line S N, and there keep it fast, making Marks with your *Protracting* Pin, against those Degrees which the *Index* cut when the *Sights* thereof were directed to the several *Objects* at A, B, C, *&c.* as against 23 Deg. 30 M. 48 D. 45 M. 78 D. 15 M. *&c.*

Third-

Thirdly, From the Point S, through your firſt Point, draw the right Line S *a* at liberty, and from the Point S, thro' the ſecond Point, draw the right Line S *b* at liberty, and ſo through all the reſt of the Points draw the Lines S *c*, S *d*, S *e*, S *f*, S *g*, S *h*, S *i* and S *k*: Then

Fourthly, Apply the *Protractor* to the *Stationary* Line S N, laying the Centre upon N, and the Diameter upon the Line S N, and make Marks or Points againſt the Degrees cut by the *Index* at the *ſecond Station* at N: As againſt 12 D. 45 M. 19 D. 30 M. 40 D. 45 M. *&c.* and through thoſe Points draw Lines from N, as the Lines N *a*, N *b*, *&c.* And where thoſe Lines interſect, or croſs each other (each to his Correſpondent) as where the Line S *a* croſſes the Line N *a*, which will be at A, that is the Point of the *firſt Object*: And ſo of all the reſt. As

Where the Line	N b	Croſſes the Line	S b	Which will be at the Point	B	the	Second
	N c		S c		C		Third
	N d		S d		D		Fourth
	N e		S e		E		Fifth
	N f		S f		F		Sixth
	N g		S g		G		Seven.
	N h		S h		H		Eighth
	N i		S i		I		Ninth
	N k		S k		K		Tenth

Obj.

And thoſe Points A, B, C, D, *&c.* are the true Places of the reſpective *Objects*, to which you directed your *Sights* from S and N.

2. *By Calculation.*

I ſhall not need to give *Examples* in the Diſtances of all the *Objects* from the *Stations*, nor of all the *Diſtances* of them one from another; it ſhall ſuffice to inſtance in *One*, by which all the reſt may be found in the ſame manner, and by the ſame *Proportion*: And that ſhall be in the *Object* at A, and the two *Stations* at S and N do make an *Oblique angled Triangle* A S N; in which there is given, (1.) The *Angle* made at the *firſt Station* S, to A, 23 Deg. 30 M. (or it's Complement to 180 De. *viz.* 156 Deg. 30 M. equal to the *Angle* A S N,) (2.) The *Angle* obſerved at the *ſecond Station* N, to A, *viz.* 12 Deg. 45 M. equal to the Angle A N S; by the help of which, the third *Angle* S A N may be found; for the Sum of the other two 156 Deg. 30 M. and 12 Deg. 45 M. is 169 15, whoſe Complement to 180 Deg, is 10 Deg. 45 M. for the Angle S A N. And (3.) The Stationary Diſtance S N 1000 Paces. By which may be found (1.) The Diſtance of the *Object* at A to N; and (2.) From A to S. By this *Canon* following.

(1.) As the Sine of the *Angle* at the *Object* A, 10 D. 45 M.	9.27073
Is to the Sine of the *Angle* made at the *Sta.* S, 23 D. 30 M.	9.60070
So is the *Stationary Diſtance* S N 1000 Paces,	3.00000
	12.60070
To the *Diſtance* of the *Object* at A, from the *Station* at N 2138 *Paces*	3.32997

(2.) As

(2) As the Sine of the *Angle* at the *Object* at A, 10 D. 45 M. 9.34379
Is to the Sine of the *Angle* made at the *Sta.* N, 12 D. 45 M. 9.34379
So is the *Stationary Distance* S N, 1000 Paces, 3.00000

To the Distance of the *Object* at A, from the *Station* at S, 1183 Paces, 12.3437½ / 3.07306

And in the same manner may all the rest of the Distances be found.

II. *Of* Surveying *of* Land, *by the* Perambulator.

Argument.

I Shall not herein, again reiterate the Manner how to take the *Plot* of any *Field*, or other *Enclosure*, at *one Station* taken in the *Middle*, one *Side* or *Angle* thereof: Neither by going round about the same, either without or within, and making *Observations* of the *Quantities* of every notable *Angle* of the same in *Degrees* and *Minutes*: All which are already sufficiently taught how to perform (several ways) in the *Fourth Book* hereof: Notwithstanding, all such Performances may be wrought by this Instrument also, by help of the two outermost *Limbs* (or *Margins*) of this *Semicircle* which are number'd by 10, 20, 30, &c. to 180, in the *uppermost*; and again, from 180, by 190, 200, 210, &c to 360 Deg. in the *Margin* under it: By the Directions given in those *Chapters*, where the Performance of such *Conclusions* are particularly treated of, as also in the preceding *Problems*.

And therefore, my Business here shall be, only to shew you how to take the *Plot* of any *Park*, *Chase*, *Forrest*, or other *large* Piece of *Ground*, by this *Instrument*; by the Assistance of the *Needle*, and the innermost *Margin* of the *Semicircle*, which is divided into two *Quadrants*, each number'd by 10, 20, 30, &c. from S, both ways, towards E and W; which *Quadrants* (or *Quarters*) I call, one the { *South East* / *North West* } Quadrant; and the other, the { *South West* / *North East* } Quadrant.

And now, to prevent Mistakes in the Use of this *Instrument* (the *Semicircle* being double number'd.) I will (in the first place) lay down some general cautionary *Rules*, carefully to be observ'd in the using of it: As

1. That (at what *Place* or *Angle*, you set down your *Instrument*, to make any *Observation*) you set it upon its *Staff* as *level* as you can: And then, move it by help of the *Ball* in the *Socket*, 'till the *North* and *South* ends of the *Needle* do hang directly over the *North* and *South Points* noted in the *Bottom* of the *Box*:

And there keep the whole *Instrument fixed*, 'till you have made your Observation.

2. When the *Instrument* is thus fixed, the *Diameter* of it will point to the *East* and *West*: And the *Semidiameter* (in which the *Box* and *Needle* is) will point towards the *North* and *South* Quarters of *Heaven*; as the *Letters* E, W, N, S, engraven upon the *Instrument* do signify.

3. When you direct your *Sights* to any *Object*, you must always count the Degrees cut by that *End* of the *Index* which is fartheſt from your *Eye*, and *denominate* them by the *Name* of that *Quarter*, which the *End* fartheſt from your *Eye* pointeth towards; as *South East* or *South West* (ſo many Degrees as are cut by the *Index*) if the End of the *Index* fartheſt from your *Eye* do reſt upon the *Semicircle*: But *North East* or *North West* (ſo many Degrees as are cut by the *Index*) when the End of the *Index*, fartheſt from your *Eye*, falls *off* of the *Semicircle*.

4. In *Surveying* of *Land* by this *Inſtrument*, by going about the *Ground* you are to meaſure, (whether within the Ground, or on the out-ſide thereof) you need not, as in the Uſe of the *Theodolite*, take *Back-Sights* at every *Angle*, and ſo find the Quantity of it; but you may go on ſtill forward, and ſo you have the Quantity that every *Angle* makes with the *Meridian*: And your Chain Line, which is beſt (eſpecially) in large *Grounds*.

PROP. V.

How to Survey, *and make a* True Plot *of any large irregular Piece of* Ground, *with all remarkable Things therein contained and adjoyning.*

LET *Old-Oak-Mead*, (*Figure* 5.) be to be Survey'd.

Firſt, Having prepar'd your *Field Book*, as in the following *Figure* thereof: Make the Point A to be the Place for your *firſt Station*; at which Place ſet up your *Inſtrument*, *Level*, and the *Needle* over the *North* and *South Line* in the *Box*: Then look for, (or ſet up) ſome *Mark*, or *Beacon* at B: To which direct your *Sights*, and ſo doing, you will find the *Degrees* cut by that End of the *Index* fartheſt from your *Eye*, to be 43 Deg. 30 Min. in the *North Weſt* Quadrant of the *Inſtrument*, (becauſe the farther End of the *Index* fell off of the *Semicircle*) which ſet down in your *Field Book* in the *middle Column* thereof, whoſe *Title* is [*Station Lines*] and finding that the Station Point A, is diſtant from the Hedge on your Left-hand 70 Links of your Chain; ſet down 0 Ch. 00 Lin. in the *middle Column*, and 0 C. 70 Lin. in the *Left-hand Column* of

of your *Field Book*: And alſo, you may find, by directing your *Sights* to an *Elm* ſtanding in the *Field*. the Degrees cut by the End ſo the *Index* fartheſt from your *Eye*, in the N W Quarter 20 Deg. which ſet down in the *Right-hand Column* under [*Remarks.*]

Secondly, Meaſure with your Chain from the Station A towards B, and in your going along, you ſhall find, That

At the End of	4 Ch. 40 L.	of *Ram-hook Mead*, The *Hedge* was diſtant from your *Chain L.* towards the *Left-hand*	11 C. 1.55 L.		
	5 30		4 30		
	9 00		3 05		
	10 00		0 65		
	15 90		1 40		

All which ſet down, as you ſee them in the *Figure* of your *Field Book*: And under them draw a Line quite croſs your Book, to ſignify, that you are come to the End of your *firſt Length*; all which *Hedge* is the Boundary of *Ram-hook Mead*: Which note in your *Field Book* in your Column of Remarks.

Thirdly, Bring your Inſtrument to your *ſecond Station* at B, and there placing it level, and the Needle hanging directly over the North and South Line in the Box, direct your Sights to C, where you will find the Degrees cut by the End of the Index fartheſt from your Eye, to be 7 Deg 30 M. in the N. E. Quarter, becauſe that End of the Index fell off of the Semicircle: Then your Station Point B, being 85 L. diſtant from the Hedge, ſet down 0 Ch. 00 L. in *middle Column*, and 0 C. 85 L. in the *Left-hand Column*. Alſo your *Inſtrument* ſtill ſtanding at B, direct the Sights to the *Elm*, where the *Index* will cut S. E. 71 Deg. And directed to the *Barn*, it will cut 60 Deg. in the N. E. Quadrant, both which ſet down in the *Right-hand* Column of *Remarks*: And then meaſure with your Chain from B towards C, taking notice of the *Breaks* in the *Hedge*, and *meaſuring* of the *Off-Sets*, ſet them all down in your *Field Book* in the Middlemoſt and Left-hand Columns; and becauſe the Hedge on the Left-hand of your Chain Line, was the Hedge next the *Road*, note that alſo down in your Left-hand Column of *Remarks*, as you ſee them done in the Field Book.

Fourthly, Remove your Inſtrument to C, the place of your *third Station*, and there ſetting it Level, and the Needle over the North and South Line in the Box; if you direct your Sights to D, you will find that the End of the Index fartheſt from your Eye, will cut 64 Deg. in the South Eaſt Quadrant, becauſe the End of the Index fartheſt from your Eye did reſt upon the *Semicircle* in that *Quadrant*; which note down in your *Field Book*: And now if you direct your Sights to the *Church*, you will find the Index to cut N. E. 30 Deg. and directing them to the *Barn*, to cut S E 22 Deg. and that the *Hedge* is diſtant from your *Station Point* at C 85 Lin. All which you muſt ſet down as is done in the Figure of the *Field Book*: Then, in meaſuring along from C to D, you do not find any notable Breaks

in

in the River on your Left-hand, but a gradual bending like a *Bow*, therefore, you muſt, in meaſuring along, take the Diſtances from your *Chain Line* to the *River*, at the End of every *Chain*, or two *Chains*, as is here done at every ſecond Chain; which Diſtances ſet down, and alſo the *River* as its Boundary, as is done in the *Field Book*.

Fifthly, Remove your Inſtrument to your fourth Station at D, ſetting it level and directly North and South (as at other times) direct the Sights to E, where you will find the End of the Index fartheſt from your Eye to cut 57 Degrees in the N. E. Quadrant, which ſet down; and at the ſame time alſo, direct the Sights to the *Church*, where you will find it to bear from you N. W. 36 Deg. And being directed to the *Old Oak*, you will find that to bear from you S. W. 70 Deg. all which note down in your Field Book. And then meaſuring from D towards E, you'll find, that at 0 Ch. 80 Links end, the *River* is diſtant from your *Chain Line* 60 Links; and at 1 C. 35 Lin. it is diſtant 75 Links, and that between theſe two is the *Mill-Houſe*: All which ſet down as you ſee done, and meaſuring on towards E, obſerving the *Breaks* made by the *River*, you will find them to be ſuch as are ſet down in the *Field Book* under *Station* ⊙ 4. And now being arriv'd to your *fifth Station* Point at E, there place your Inſtrument, and rectify it; but, (before you direct your *Sights* to the next Station at F,) direct them to the ſeveral Angles made by the winding of the *River*, as from E, to G, H, K, L and M: Noting what Degrees the Ends of the Index fartheſt from your Eye cuts; and alſo, meaſure the Diſtance from E to every of them, ſo will you find them to be, from E to G, 37 Deg. and the Diſtance 4 C. 30 L. *&c.* all which ſet down in the Column of *Remarks* on the Left-hand, as you ſee them done in the Figure of the *Field Book*. And then,

Sixthly, (Your Inſtrument ſtanding at E, in the ſame Poſition as before) direct your Sights to F, your *ſixth Station*, where you will find the End of the Index fartheſt from your Eye, to cut 9 Deg. in the S. E. Quadrant; which note down; and meaſuring from E towards F, you will find, that at the End of 1 C. 75 L. the River will be diſtant from your Chain Line 55 L. and at the End of 5 C. 10 L. the Chain Line will paſs juſt by (or touch) the Brow of the *River*. All which ſet down in their proper Places, as you ſee them in the *Field Book*. And

Laſtly, Remove your Inſtrument to F, your *ſixth Station*, rectifying it as before, and direct your Sights to A, your *firſt Station*, where you will find that End of the Index which is fartheſt from your Eye to cut 41 Deg. 30 Min. of the S. W. Quadrant: And alſo, being directed to the *Old Oak*, it will cut 70 Deg. in the S. W. Quadrant; both which ſet down in their proper Columns of your *Field Book*: And then meaſuring from F towards A, you find that your Station Point at F is diſtant from the Hedge of *Broom-Field* 1 Chain, and at the End of 11 Ch. 30 L. there is a *Gate* in the Hedge going into *Broom-field*, which with all the *Breaks* and *Bend-*

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ings in the Hedge between F and A, you must measure and set down as you see done in this Figure of the *Field Book* for this *Meadow*: And thus is your Work in the *Field* ended.

FIELD-BOOK:

A Survey of Old-Oak Mead, *in the County of* Devonshire, *being Part of the Demeasn of* W. R. *Esq; Surveyed in the Month of* August, *Anno* 1683. *By* W. L.

REMARKS.		Sets off C	Sets off L	Station Lines At C	Station Lines At L	Sets off C L	REMARKS.
				St. ⊙ 1		NW	43 Deg. 30 Min.
	Ram-hook Meadow.	0	70	0	0		At Station ⊙ 1 the Elm Bears N. W. 20 Deg.
		1	51	4	40		
		4	30	5	30		
		3	05	9	00		
		0	65	10	00		
		1	40	15	90		
				St. ⊙ 2		N. E.	7 Deg. 30 Min
		0	85	0	00		At Station ⊙ 2 the Elm bears S. E. 71 Deg. And the Barn bears N. E. 60 Deg.
	The Road to *Collitn.*	A Gate		2	10		
		1	95	3	85		
		1	75	4	15		
		1	35	5	70		
		0	65	8	10		
		1	65	10	85		
At Station 3, The Church Bears. N. E. 42 Deg.				St. ⊙ 3		S. E.	64 Deg. 0 m.
		0	80	0	00		At Station ⊙ 3 the Barn bears S.E. 22 Deg.
		1	50	2	00		
		1	90	4	00		
	The River.	2	20	6	00		
		1	85	8	00		
		1	40	10	00		
		1	30	11	90		
At Station 4, The Church Bears. N W 36 Deg.				St. ⊙ 4		N. E.	57 Deg. 0 m.
		0	60	0	80		The Mill House. At Station ⊙ 4, Old Oak bears S. E. 30 Deg.
		Mill					
	River.	0	75	1	35		
		2	40	3	70		
		1	30	6	20		
				9	55		
At the End of ⊙ 4 . . . There is an Out-let Bearing.				St. ⊙ 5		S. E.	9 Deg. 0 m.
				0	00		
		0	55	1	75		
		touch		5	10		
		1	60	8	30		
		1	00	10	10		
				St. ⊙ 6			At Station ⊙ 6 Old Oak bears S. W. 70 Deg.
				S. W.			
				11 d. 30 m.			
		1	00	0	00		
		1	50	3	35		
		2	65	3	50		
		0	90	6	40		
	Broom-Field.	2	60	9	10		
		A Gate		11	30		
		0	90	13	10		
		1	80	17	15		

C	L
NW 37 D.	4. 30
NW 3	5. 40
NE 23	6. 30
NE 64	5. 35
SE 85	4. 00

The *Work* in the *Field* thus finiſhed, it reſteth now to ſhew you how to *protract*, or make a true *Plot* of it upon *Paper*, *Parchment* or *Velom:* But before you begin that Work, you may (if you will take the Pains, which will compenſate the Labour, and abundantly ſatisfy you in your Performance) know, whether your *Plot* will cloſe or not, that is, whether, when you come to lay down your laſt *Chain Line* F A, whether the Length you meaſure from F to A, will, upon your *Plot*, reach to, or fall upon the firſt Point A: Which if it do, your *Field Work* is rightly performed, otherways not; and the Error which cauſes the Difference may be either in the *Quantities* of the *Angles*, or in the Lengths of the *Lines*, or both: Which, how to diſcover, ſhall be ſhew'd in this following Problem.

PROP. VI.

How to know whether the Station Lines *in the former* Plot *will* cloſe *or not, before you begin to* protract, *or lay them down upon* Paper.

FIRST, Prepare a Table, which divide into ſix Columns, as the Table following; in the firſt Column, ſet down the Degrees cut by the Index at every Station, with the Name of the Quadrant or Quarter in which they were obſerv'd to be in at every Station, which you muſt take out of your *Field Book*: So, at *Station* ⊙ 1, the Index cut 43 Deg. 30 Min. in the N. W. Quadrant: Which ſet down in the firſt Column of the following *Table*; and right againſt it, in the ſecond Column, ſet the Length of the *Chain Line* between the Firſt and Second *Stations*, which was (as appears by the *Field Book*) 15 Chains 90 Links: So will the firſt Line of the Firſt and Second Columns ſtand thus:

At Stat. ⊙ 1 A. N. W. 43 D. 30 M. | 15 C. 90 L.

And ſo all the reſt of the *Angles* at every *Station*, and the *Chain Lines* between Station and Station, taken out of your *Field Book*, and put into a Table ruled for that purpoſe, they will ſtand as in the two firſt Columns of this following *Table*.

	D. M.	C. L.	Eaſt C. L.	Weſt C. L.	North C. L.	South C. L.
At St. ⊙ 1 A. N. Weſt	43. 30	15. 90		10. 94	11 53	
At St. ⊙ 2 B. N. Eaſt	7. 30	10. 85	1 42		10 76	
At St. ⊙ 3 C. S. Eaſt	64. 00	11. 90	10 70			5. 22
At St. ⊙ 4 D. N. Eaſt	57. 00	9. 55	8. 01		5. 20	
At St. ⊙ 5 E. S. Eaſt	9. 00	10. 19	1 66			9. 97
At St. ⊙ 6 F. S. Weſt	41. 30	17. 15		10 85		12. 30
The Sums of the Columns			21. 79	21. 79	27. 49	27. 49

The

The two firſt Columns of this Table being taken out of your *Field Book*, and enter'd into this *Table*; the other four Columns noted at the Head with *Eaſt*, *Weſt*, *North* and *South*, muſt be ſupply'd by working of the following Proportion (either by the *Tables* of *Sines* and *Logarithms*; or by the *Lines* of *Sines* and *Numbers* in the third *Book*.) The *Analogy* or *Proportion* being thus,

As the Radius, or Sine of 90 Deg.
Is to the *Length* of the *Chain Line*:
So is the *Sine* of the *Degrees* cut by the *Index*, at every *Station*,
To the *Chains* and *Links* of the *Eaſting* or *Weſting*.

And

As the Sine of 90 Deg. is to the *Length* of the *Chain Line*,
So is the *Sine Complement* of the *Degrees* cut by the *Index*,
To the *Northing* or *Southing*.

The firſt Obſervation wrought by the Tables.

As the *Sine* of 90 Deg.	10.00000
To the Length of the Chain *Line* A B. 15 D. 90 M.	1.20139
So is the *Sine* of the *Degrees* cut at that Sta. 43 D. 30 M.	9.83781
To 10 C. 94 L. for the *Weſting*,	×1.03920

And therefore muſt be put in the *Weſt* Column of this *Table*, becauſe they were cut by the *Index* in the *North Weſt Quadrant*.

Again,

As the Sine of 90 Deg.	10.00000
To the Length of the *Chain Line* A B. 15. 90.	1.20139
So is the Co-Sine of the *Degrees* cut 46 Deg. 30 M.	9.86056
To 11 C. 53 L. for the *Northing*,	×1.06195

And therefore muſt be ſet in the *North* Column of this *Table*, becauſe the Index cut them in the *North Weſt Quadrant* of the *Inſtrument*.

And this Work muſt be done at every *Station* (that is, ſix times in this *Example*) which, if it ſeem tedious, it may be more readily performed by the *Lines* of *Sines* and *Numbers*, by the ſame Proportion: For,

If you extend the Compaſſes from the *Sine* of 90 Deg. to the Length of the *Chain Line* 15 C. 90 L. on the *Line* of *Numbers*: That Extent will reach from the *Sine* of 43 Deg. 30 M. (the *Degrees* cut by the *Index*;) to 10 C. 94 L. upon the Line of *Numbers*; for the *Weſting*: And the ſame Extent will alſo reach from the Sine of 46 Deg. 30 M. (the *Complement* of the *Degrees* cut) to 11 C. 53 L. upon the Line of *Numbers*, for the *Northing*, as before.

Thus working by either of theſe ways for every *Station*, and ſetting down the Diſtances of *Eaſting* or *Weſting*: And *Northing* or *Southing* in their reſpective Columns [as above is done] your *Calculatory* Work is ended: And then,

Add up every *Column* ſeverally, and if you find the *Sums* of the *Eaſt* and *Weſt* Columns to be *equal*: And alſo the *Sums* of the

North

North and *South* Columns to be *equal*; as in the Table above they are; you may then aſſure yourſelf, that your Work is true, and that your *Chain Lines* will *cloſe*: And now you may with Confidence proceed to the *Protracting*, or laying down the *Plot* of your *Field*, which, how to perform is ſhew'd in the following *Propoſition*.

How to protract *the former* Obſervations, *and to make a true* Plot *of your* Field.

UPON your *Paper* or *Vellom*, provided for that purpoſe (*Fig.* 5.) draw a right Line quite through the ſame, as the Line N S, repreſenting the *General Meridian*: And,

Firſt, Aſſume any convenient Point upon it, as the Point A, for your *firſt Station*: Upon which Point A, lay the Centre of your *Protractor*, (which ought, moſt conveniently, to be a whole *Circle*, having a *Flower-de-Luce* at the *North*, and the four Quadrants thereof divided each of them into 90 Deg. and number'd from the *North* and *South Points*, towards the *Eaſt* and *Weſt*, by 10, 20, 30, *&c.* to 90 Deg. and every Quadrant nam'd according to its proper *Coaſt*, that is, *South Eaſt* and *South Weſt*, on either ſide of the *South* Point: And *North Eaſt* and *North Weſt*, on either ſide of the *North* Point.) The Centre of the Protractor being laid to the Point A, turn it about 'till the Diameter thereof do lie juſt upon the *Meridian Line* of your Paper, the *Flower-de-Luce* towards N, and there hold it cloſe to the Paper: Then your *Field Book* lying before you, look what Degrees were cut by the Index at that firſt Station, and in what *Quarter*, and you will find them to be 43 Deg. 30 M. in the *North Weſt* Quadrant: Againſt which Degrees, in that *Quadrant* of your *Protractor*, and cloſe by the Edge thereof, make a Mark with your *Protracting Pin*; and alſo, becauſe (at that *Station*) the *Elm* did bear from you *North Weſt* 20 Deg. make another Mark at thoſe Degrees alſo cloſe to the Edge of your *Protractor*; then take away your *Protractor*, and through your firſt Point, from the Point A, draw a right Line, for your *Chain Line*, which by your Book you find did contain 15 Ch. 90 L. which taken from any Scale, and ſet upon the *Chain Line* from A to B, the Point for your *ſecond Station*: And alſo, through the ſecond Point made at N. E. 20 Deg. draw a Line at pleaſure, as the Line A, O, not ſetting any Number to it.

Secondly, Through the Point B, your *ſecond Station*, draw an obſcure Line *n* B *s* Parallel to the *General Meridian* Line N. S. firſt drawn: Then, bring the Centre of your *Protractor* to the Point B, and the *Meridian* Line thereof to lie juſt over the obſcure Line *n* B *s*, and there keep it cloſe to the Paper: And look in your *Field Book*, what Degrees were cut by the Index at your *ſecond Station*, which you'll find to be 7 Deg. 30 M, in the N. E. Quadrant, againſt which Degrees make a Mark, cloſe by the Edge of the *Protractor*:

And

And alſo, becauſe (at that Station) the *Elm* did bear from you *South Eaſt* 71 Deg. make there a ſecond Mark by the Edge of the *Protractor*: Then taking away the Protractor, through your firſt Point, and the Station Point B, draw a Line for your *Chain Line*, which by your Book contains 10 Ch. 85 L. which ſet from B to C, ſo is C the the Point of your third Station: Alſo, through the ſecond Mark, draw a Line at pleaſure, as the Line B P, croſſing the Line A O drawn at pleaſure from the *firſt Station*, for that Point is the Place where the *Elm* ſtands in the *Field*.

Thirdly, Through the Station Point C, draw an obſcure Line *n* C *s*, parallel to the *General Meridian* Line N S; and laying the Center of your Protractor upon C, and the *Meridian* thereof upon the Line *n* C *s*, there hold it cloſe to your Paper, and ſeeing that the Degrees cut by your Index at your *third Station* were 64 Deg. in the *South Eaſt* Quadrant, againſt thoſe Degrees make a Mark by the Edge of the Protractor, through which to draw your *Chain Line*: And alſo, becauſe (at this Station) there was a *Church* which did bear from you *North Eaſt* 42 Deg. and a *Barn* which did bear from you *South Eaſt* 22 Deg. make Marks againſt thoſe Degrees alſo, through which draw two obſcure Lines at pleaſure, as the Lines C Q and C R, not ſetting any numbers to them, but upon your *Chain Line*, you muſt ſet the Length thereof as you find it in your *Field Book* 11 Ch. 90 L. from C to D, which point D, is the Point for your fourth Station.

Fourthly, Through this Station Point D, draw an obſcure Line *n* D *s*, parallel to the *General Meridian* Line N S. Then laying the Center of your Protractor upon D, and the Meridian Line of it upon the Line *n* D *s*, hold it faſt cloſe to the Paper; and foraſmuch as the Degrees cut by your Index at the *fourth Station*, were 57 Deg. in the *North Eaſt* Quadrant: Againſt thoſe Degrees make a Mark by the Edge of the Protractor, through which your *Chain Line* muſt be drawn: And alſo, becauſe (at this *fourth Station*) the *Church* did bear from you *North Weſt* 36 Deg. and an *Old Oak South Eaſt* 30 Deg. make Marks againſt thoſe Degrees alſo in their proper Quadrants, through which draw two obſcure Lines at pleaſure, the one D T, croſſing the obſcure Line C Q drawn from the third Station at C, in the Point where the Church is to ſtand; and the other D V, which will paſs through the Point where the *Old Oak* ſtands, ſetting no Numbers to theſe Lines, but to your *Chain Line*, you muſt ſet the Length thereof 9 Chains 55 Links, from D to E, which is the Point of your *fifth Station*.

Fifthly, Through the Station Point E, draw an obſcure Line *n* E *s*, parallel to the *General Meridian* Line N S, Then, laying the Center of your Protractor to the Point E, and the *Meridian* thereof upon the Line *n* E *s*, keep it there faſt: And repairing to your Field Book, you there find that there is ſeveral *Out-let Bearings* againſt this *Station Point* E, as *North Eaſt* 36 Deg *North Weſt* 3 Deg. *&c.* againſt all which numbers of Degrees in their ſeveral *Quadrants*, make Marks by the Edge of the *Protractor*, and through them draw ob-

ſcure Lines from the *Station Point* E; ſetting upon each of them, ſuch Lengths as you find noted againſt them, in your Field Book, as againſt the firſt, there is 4 C 30 L. which ſet from E to G, againſt the Second 5 C, 40 L. which ſet from E to H, do ſo with the reſt, ſetting them from E, to K, L and M, and then if you draw the Lines G H, H K, K L, and L M, you will have *protracted* your *Out-let Piece:* And foraſmuch as the Degrees cut the Index at this *fifth Station*, were 9 Deg. in the *South Eaſt* Quadrant (your *Protractor* reſting as before) make a Mark againſt 9 Deg. in the *South Eaſt* Quadrant, and through it draw your *Chain Line*, ſetting upon it the Length as you find it in the Field Book, 10 C. 10 L. from E to F, which point F, is the place of your *ſixth* and laſt *Station*; Then

Sixthly, Through the Point F, draw an obſcure Line, *n* F *s*, parallel to the *General Meridian*, and to the Point F, apply the Centre of your Protractor, laying the *Meridian* thereof upon the Line *n* F *s*, where fix it; then look into your *Field Book*, where you ſhall find, that at your *ſixth Station* at F, the Index did cut 41 Deg. 30 Min. in the *South Weſt* Quadrant, make a Mark at them, cloſe to the Edge of the Protractor, through which your laſt Chain Line muſt paſs; and (if you have committed no former Error in your Protraction) it will paſs through the *firſt Station* Point A, and contain in Length 17 C. 15 L. as by your *Field Book* you ſee it ought to do. And becauſe at this *ſixth Station* youfind by your *Book*, that the *Old Oak* did bear from you *South Weſt* 70 Deg. make a Mark by the Edge of your Protractor (it reſting in the former Poſition) through which, draw an obſcure Line from F, as F X, croſſing the obſcure Line D V before drawn from the *fourth Station* Point D, in the Point where the *Oak* ſtands in the *Field*.

And thus having protracted your *ſixth Chain Line*; the *Out-let* at the *fifth Station* E, as alſo, the *Church*, the *Elm*, the *Barn* and the *Old Oak*, all in their proper places: It remains in the next place to protract the ſeveral *Off-ſets* againſt every *Chain Line*, and draw the *irregular Hedges*, *River* and *Highway*.

For the *protracting* of the *Off-ſets*, and drawing the *irregular Hedge Lines*, it is to be performed altogether in the ſame manner, as is taught how to do in that *Chapter*, which ſheweth how to *Survey* and *Plot* a *Field*, or other *irregular Piece* of *Ground* by the *Chain* only: Notwithſtanding, I will repeat the manner thereof again, in laying down the *Hedge* lying on the *Left-hand* of your *firſt Station* Line A B.

Firſt, By your *Field Book* you find, that at your *Station-Point* A, the *Hedge* was diſtant from A 70 Lin. Take from the *Scale* you protracted the Station Lines by, 70 Lin. and prick them down upon your Paper from A to 1,

Secondly, By your *Book* you find, that at 4 C. 40 L. from A, you ſet off from your *Chain Line* 1 C. 55 L. Take 4 C. 40 L. and ſet them from A to 2, and 1 C 55 L. and ſet them from 2 to 3 perpendicular to the *Chain Line*.

Thirdly,

Thirdly, You find by your *Book*, that at 5 C. 30 L. from A, your *set-off* was 4 C. 30 L. Take 5 C. 30 L. and set them from A to 4, and 4 C. 30 L. and set them from 4 to 5.

Fourthly, You find that at 9 Ch. from A, your *Off-set* was 3 C. 5 L. Take 9 C, and set them from A to 6, and 3 C. 05 L. and set them from 6 to 7.

Fifthly, You find that at 10 Chains from A, your *Off set* was 65 L. Take 10 Chains, and set them from A to 8, and 65 L. and set them from 8 to 9. And

Lastly, You find, that at 15 C, 90 L. from A, (which is the End of that *Station Line*) your Off-set was 1 C. 40 L. which set from B to 10, perpendicular to the *Chain Line*.

And then, if your draw the several *Lines* 1—3. 3—5. 5—7. 7—9. 9—10. you will have *protracted* the *crooked Hedge* lying against your *first Station* Line A B.

In this manner, you must *protract* all the rest, for the performance whereof, the comparing of the *Field Book* and *Plot* together, (with what hath been said already) will give the intelligent *Reader* far better Satisfaction than a multitude of Words.

How the foregoing Field Work *may be abreviated.*

HAving assumed the Points A, B, and C, (*Fig.* 5.) for your *First*, *Second* and *Third Stations*, and set up *Marks* or *Beacons* at either of them. Begin your Work in the *Field* thus:

First, Measure with your Chain from A, towards B, and at the several *Distances*, as you go along take notice of your *Breaks* in the *Hedge*, and your *Off sets* to them, and set them down in your *Field Book*, as before; and when you come to B, there set up your *Instrument*, level and directly *North* and *South*, as before: And then,

Secondly, Direct the Sights upon the *Index* backwards to A, where you will find the End of the Index next to your Eye, to cut N. W. 43 Deg. 30 M. the same as at the End of the Index fartheſt from your Eye did before at A; and set them down in your *Field Book* in the same Place as before: And then (the Instrument still standing at B,) direct your Sights to C, where you will find the End of the Index, fartheſt from your Eye, to cut N. E. 7 Deg. 30 M. the same as before, and measuring on to C. set off your Distances, *&c.*

Thirdly, Measure from C to D; where set up your *Instrument*; and directing Sights back to C, you will find that End of the Index next to your Eye, to cut S. E. 64 Deg. the same as before were cut from C to D: And then directing your Sights to E, you will find the End of the Index fartheſt from your Eye, to cut N. E. 57 Deg. the same as before: And then measure from D to E, setting down your Lengths and Off-sets, as in the Book you find them.

Fourthly, Measure from E to F; and there set up your Instrument: And directing your Sights back to E, you will find that End of the

Index

Index which is neareſt your Eye, to cut S. E. 9 Deg. And alſo, direct the Sights to A, you will find the End of the Index fartheſt from your Eye to cut S. W. 41 Deg. 30 M. the ſame as before: All which being ſet down in your Field Book, you will find to be the ſame as were ſet down before; there is only this *Abreviation, viz.* That whereas you did, before, ſet your *Inſtrument* up at *ſix* ſeveral *Places*; here you ſet it up but at *three*; which is very well worth the noting: For the fewer times that you ſet up the *Inſtrument*, the fewer Errors you will commit:

For the *Protraction*, that will ſtill be the ſame as in the laſt.

A more Exact *way for the caſting up of the ſmall* Triangles, Trapezias, *and other ſmall irregular* Pieces *of* Ground *which lie between the* Hedges *and your* Chain Lines, *in going about any irregular* Piece *of* Ground *to Survey it.*

IN going about a *Field*, and making Obſervation at every material Angle, where you ſet up *Marks* or *Beacons*: In meaſuring from *Beacon* to *Beacon*; as you paſs by any ſmall *Bow* or *Bending* in the *Hedge*: You (1.) Note down at what number of *Chains* and *Links*, ſuch a *Bow* or *Bend* is from your *Beacon*, and ſet that Number down in the middle Column of your *Field Book*: (2.) You meaſure from your *ChainLine* up to that *Bow* or *Bending*, and note that Diſtance down in your *Field Book* in one of the *ſide Columns* (on the Right-hand Column, if your *Hedge* be on your Right-hand; or, on the Left-hand Column, if the *Hedge* be on your Left-hand.

Then, when you come to *plot* your *Field*, you firſt lay down the *Chain Lines*, which you meaſured in the *Field*, which will include the greateſt Part of the *Field*: Within the Limits of thoſe Lines, in a Figure of *four*, *five* or *ſix Lines*, all conſiſting of right Lines; the ſame which you meaſured with your Chain.

Now, this large *right lined Figure* may beſt be caſt up by dividing of it into *Trapezias* and *Triangles*; but, for the caſting up of the other ſmall Pieces, which lie between the *Chain Lines* and the *Hedges*, if you reduce them into *Triangles*, as they will be a great many in Number; ſo you will very much err in laying of them down firſt, and in taking them off afterwards: Eſpecially, if the *Scale* you protract by be very ſmall; where 10 or 12 Links of a Chain (which is half a *Rod*) is hardly to be eſtimated, altho' your *Scale* be well divided, and the Points of your Compaſſes very fine. For the removal of this great Inconvenience, I ſhall in this Place ſhew you a way not commonly uſed (becauſe it may ſeem ſomewhat tedious) where by you may caſt up the Quantities of the ſmall Pieces or Off-ſets, without reducing of them into Triangles, (and taking the Baſis and Perpendiculars

pendiculars of them by Compasses, and applying them to *Scale*) but by the Lines which you actually measured with your Chain; and so let the *Scale* you *plot* by be never so small, you shall have the true Quantity of these *Off-set Pieces* as exactly as any of the greater parts of the Field.

What I have here deliver'd in general Terms, I will now make plain by Example.

Suppose you have measured in the in-side of a Field, (by a Hedge lying on your Left-hand) a Chain Line containing 8 Ch. 12 Links; which Line let be A B, (*Fig.* 6) and that at A, the Hedge is distant 25 L. of my Chain, which I note down in my *Field Book*; and measuring forward from A towards B, at the End of 1 Ch. 20 L. I find a *Bow* or *Bend* in the *Hedge*, from which I measure (with my Chain or Rod) and find the Distance thereof from my Chain, to be 90 Lin. on my Left-hand, which I set down also in the Left-hand Column: And going on forwarder towards B, till I have measured 2 Ch. 30 L. where I meet with another Bend in the Hedge, which is distant from my Chain Line 1 Ch. 05 Lin. which I set down in my Field Book, and so all the other Lengths and Distances, according as I find them in my Passage from A to B: And when I come to B, my Observations, which I made by the way, will appear in my *Field Book* to be such as in the *Margin*: By which I may protract the Line A B, (and consequently the *crooked Hedge*) as followeth: And also to find the *Area* of all the little *Pieces* intercepted between them.

C.	L.	C.	L.	C.	L.
0	25	Station	A		
0	90	1	20		
1	05	2	30		
0	70	3	25		
1	50	5	30		
0	75	7	45		
0	25	8	12		

I. *How to Protract the same.* Fig. 6.

1. From any *Scale* of *equal Parts* (or a *Diagonal Scale* rather) take the whole Length of your *Station Line*, as you found it by Measure, 8 Ch. 12 Lin. and lay that Distance down upon Paper, from A to B.

2. From the same Scale take 25 Li. and set them from A to C.

3. Take 1 C. 20 L. and set them from A to b, and from thence set 10 C. 90 L. to D.

4. Take 2 C. 30 L. and set them from A to c, and from thence set 1 C. 05 L. to E.

5. Take 3 C. 25 L. and set them from A to d, and from thence 0 C. 70 L. set them from d to F.

6. Take 5 C. 30 L. and set them from A to e, and from thence set 1 C. 50 L. to G.

7. Take 7 Ch. 45 L. and set them from A to f, and from f, set 0 C. 75 L. to H.

8. From B, at the End of 8 C. 12 L. set 25 L. from B to K.

Lastly, Draw the Lines C D, D E, E F, F G, G H and H K, it will represent the true Shape of the *Hedge*, with all its Bows or Bends: And the streight Line A B, represents the *Chain Line*.

II. *To find the true* Area, *or* Superficial Content *of this* Irregular Figure *A C D E F G H K B, in* Acres, Roods *and* Perches.

1. The Perpendicular (or Off-set) A C, is 25 L. and the Perpendicular (or Off-set) *b* D, is 90 L. these two added together make 1 Ch. 15 L. the half whereof is 57 L. This multiplied by 1 C. 20 L. (the Distance from A to *b*,) the Product will be .08840, for the Content of the *Trapezia* L.

2. The Perpendicular (or Off-set) *b* D, is 90 L. and the Perpendicular (or Off-set) *c* E, is 1 C. 05 L. which added together, make 1 C. 95 L. the half whereof is 97 Lin. Then substract 1 C. 20 L. (your first Distance from A to *b*) from 2 C. 30 L. (your Distance from A to *c*) the Remainder will be 1 C. 10 L. which multiply by 97 L. and the Product will be .10670, for the Content of the *Trapezia* M.

3. The Perpendicular (or Off-set) *c* E, is 1 C. 05 L and the Perpendicular (or Off-set) *d* F, is 70 L. which added together, make 1 *e* C. 75 L. the half whereof is 87 L. Then substract A *c*, 2 C. 30 L. from A *d*, 3 C. 25 L. the Remainder will be 95 L. which multiplied by 87 L. the Product will be .08265, for the Content of the *Trapezia* N.

4. The Perpendicular (or Off-set) at F, is 70 L. and the Perpendicular (or Off-set) *e* G is 1 C. 50 L. which added together, make 2 C. 20 L. the half whereof is 1 C. 10 L. Then substract A *d*, 3 C. 25 L. from A *e*, 5 C. 30 L. and the Remainder will be 2 C. 05 L. And that multipy'd by 1 C. 10 L. the Product will be .22550, which is the Content of the *Trapezia* O.

5 The Perdendicular (or Off-set) *e* G, is 1 C. 50 L. and the Perpendicular (or Off-set) *f* H is 0 C. 75 L. which added together makes 2 C. 25 L. the half whereof is 1 C. 12 L. Then substract A *e*, 5 C. 30 L. from A *f*, 7 C. 45 L. and the Remainder will be 2 C. 15 L. which multiply'd by 1 C. 12 L. produceth .24030, for the Content of the *Trapezia* P.

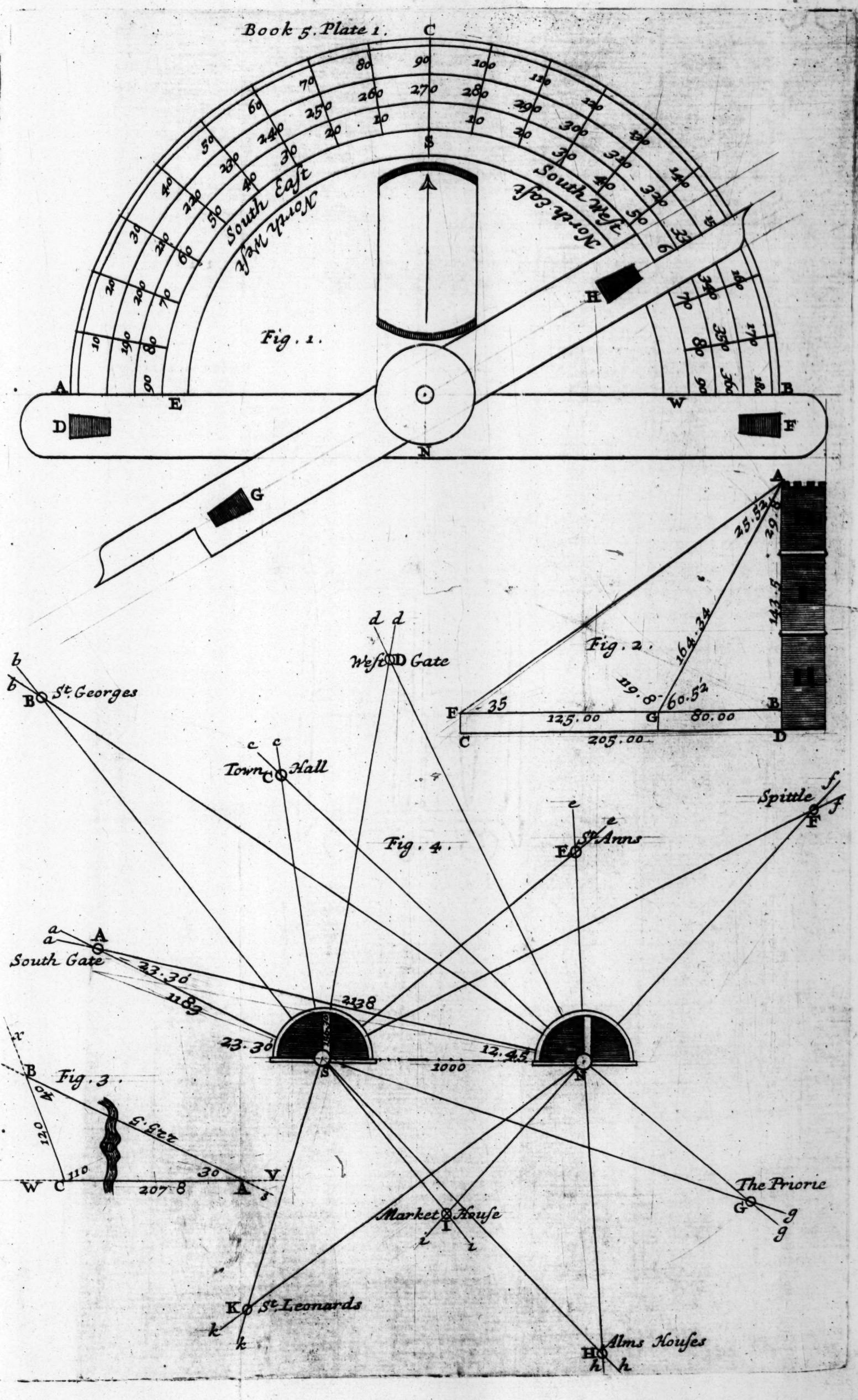
6. The Perpendicular (or Off-set) *f* H is 75 L. and the Perpendicular B K, 25 L. which added together make 1 C. the half whereof is 50 L. Then substract A *f*, 7 C. 45 L, from A B, 8 C. 12 L. the Remainder will be 67 L. which multiply'd by 50 L. the Product 03350, will be the Area of the *Trapezia* Q.

L —	.	0	6	8	4 0
M —	.	1	0	6	7 0
N —	.	0	8	2	6 5
O —	.	2	2	5	5 0
P —	.	2	4	0	8 0
Q —	.	0	3	3	5 0
Sum	.	7	5	7	5 5

7. Add all these *Products* together, as you see done in the *Margin*, the Sum of them is .75755, which *reduced* (as is before taught) makes 0 *Acres*, 3 *Roods* and 1 *Perch*, and so much Land is contained in the Piece A C D E F G H K B, between the Chain-Line and the Hedge.

The End of the Fifth Book.

THE


C
S
North East
South East
South West
North East
H
A
E
W
B
D
F
N
G
Fig. 1.
25.52
29.8
143.5
164.34
119.8
60.52
F
35
125.00
G
80.00
B
C
205.00
D
Fig. 2.
d d
West Gate
b
b
St. Georges
B
c c
Town Hall
C
Fig. 4.
e
e
St Anns
F
f
f
Spittle
a
a
A
South Gate
23.30
118
2138
23.30
1000
12.45
x
B
Fig. 3.
40
120
S. Grr
110
207 8
30
W
C
A
V
s
S
N
The Priorie
G
g
g
Market House
I
i
i
K
St. Leonards
k
k
H
Alms Houses
h
h

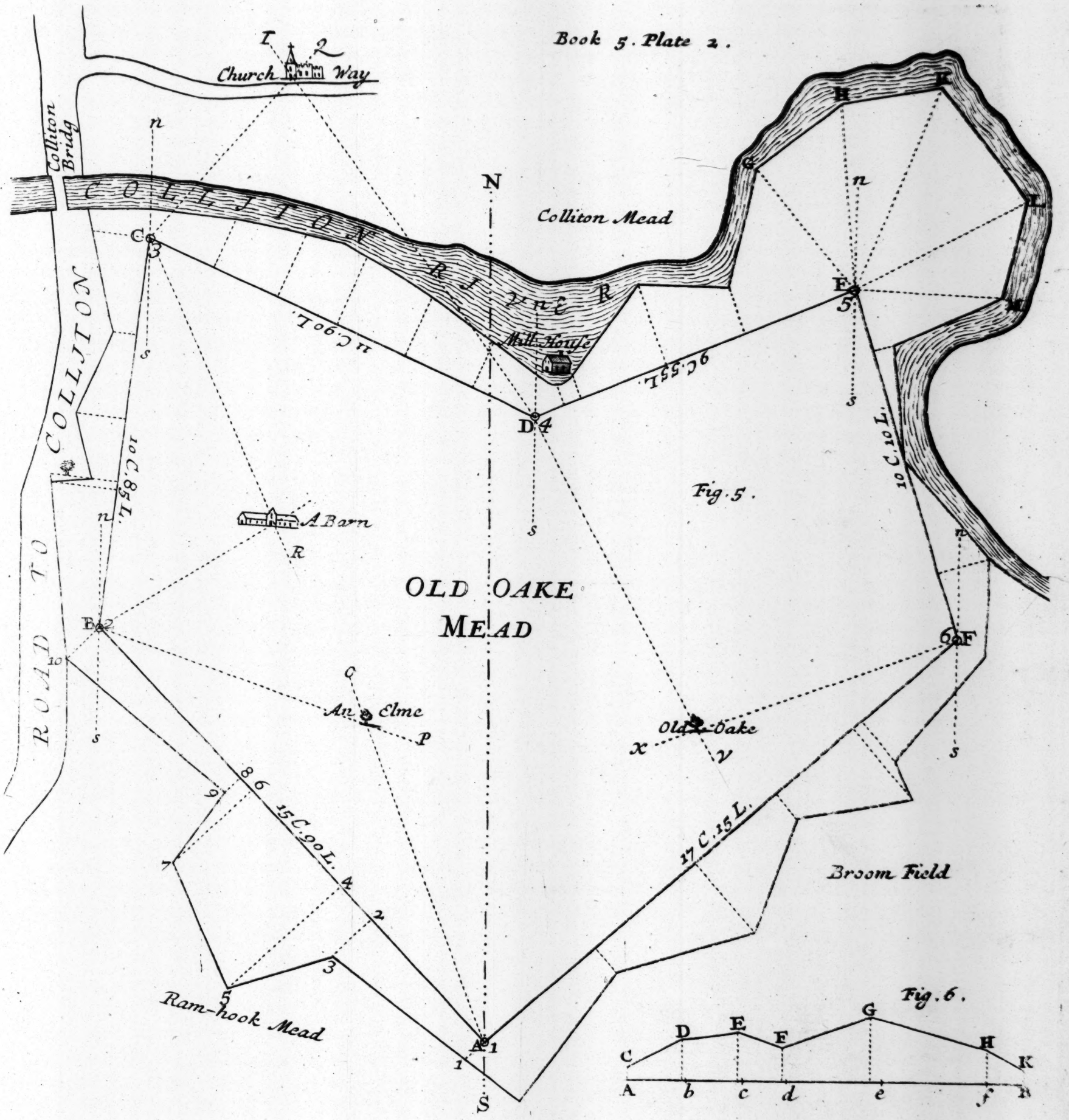

Church Way
Colliton Bridg
COLLITON RIVER
Colliton Mead
Mill House
N
n
s
C
E
D
A Barn
R
OLD OAKE MEAD
B
An Elme
P
Old Oake
x
y
ROAD TO COLLITON
10 C. 85 L.
8 C. 90 L.
9 C. 55 L.
10 C. 10 L.
8 6 15 C. 90 L.
17 C. 15 L.
Broom Field
Ram-hook Mead
A
S
F
G
H
K
L
M

Fig. 5.

C
D
E
F
G
H
K
A
b
c
d
e
f
B

Fig. 6.

THE

COMPLEAT SURVEYOR.

The Sixth Book.

Of Surveying by the Chain *only.*

The ARGUMENT.

A Surveyor may, at some time or other, be required to take a *Distance*, *Measure* a *Field*, *Close*, or *Wood*: And to make a *Plot* of the same upon *Paper* or *Parchment*; when his *Instruments* are not at hand: Now, how such *Works* may be performed without any graduated *Instrument*, (by a *Chain* only) I shall plainly shew in these few following *Examples*.

How to take an inaccessible Distance, *by the* Chain *only.*

LET A (*Fig.* 1.) be a *Tree* (or other *Object*) and you being at B, should be required to tell how far the *Tree* at A is from you:

1. Standing at B, (which call your *first Station*) look towards A, and cause some Body to move so (at some convenient Distance from B) that he may stand between your *Eye* and the *Object* at A, as at D, and there let him set up a small Stick or *Mark*.

2. From B, measure out any number of *Chains* and *Links* to any Mark set up (either on the *right* or *left-hand* from B) as to C. 7 C. 00 L. and there set up another Mark (which call your *second Station*): And

3. From thence look towards the Object at A; and at some convenient Distance from C, in the visual Line C A, cause one to set up a small Stick or Mark, as at G.

4. In any two places of the Line, between B and C, cause two Marks to be set up, as, one at E, the other at F.

5. Measure the Distances B D, B E, D E: And also the Distances, C G, C F, G F: Setting them down in a Piece of Paper with

with their reſpective Lengths to them: As in the following *Example* is here done.

From *Station* 1 at B, to *Station* 2 at C, 7 Ch. 00 Lin.

From
B to D	2	00
B to E	2	00
D to E	2	10
C to F	2	50
C to G	2	50
F to G	3	65

Theſe Meaſures being thus noted down in a Piece of Paper; you may protract, or lay the ſame down upon Paper or Parchment, by the Directions following.

How to Protract, or lay down the former Meaſures, and thereby find the required Diſtances from B *or* C *to the Object at* A.

This is to be performed by the VIII *Geometrical Problem* of the *Firſt Book.*

1. Upon Paper or Parchment, draw a right Line at pleaſure, as H K.

2. From any *Scale* of *equal Parts*, take 7 Chains (which is the Diſtance between your two *Stations*) and ſet them upon the Line H K, from B to C.

3. Take the Diſtance B D or B E 2 Chains, and with that Diſtance, ſetting one Foot of the Compaſſes in B; with the other deſcribe the obſcure Arch E *a* D.

4. From the ſame Scale, take the Diſtance D E, 2 Ch. 10 Lin. and ſet them upon the obſcure Arch, from E to D.

5. Through the two Points B and D, draw a right Line at pleaſure, as the Line B D M. Then,

6. Take the Diſtance C F or C G 2 Ch. 50 Lin. with which diſtance, ſet one Foot of the Compaſſes in C, and with the other deſcribe the obſcure Arch F *b* G.

7. From the ſame Scale, take the Diſtance F G, 3 Ch. 65 Lin. and ſet them upon the obſcure Arch, from F to G. And,

8. Through the two Points C and G, draw a right Line at pleaſure, as C G L, croſſing the former Line B D M in the Point A, which is the Point where the *Object* ſtandeth.

9. If you take the Length of the Line B A, and meaſure it upon the ſame *Scale*, from whence you took your former Diſtances, you will find it to contain 14 Chain (which multiply'd by 66, gives 924 Foot) for the *Diſtance* of the *Tree* at A, from the Place of your firſt ſtanding at B: And

10. C A being meaſured by the ſame Scale, will be found to be 12 Chains (or 792 Foot.) In this manner, not only the Diſtance of one Place, but of many Places may be taken by the often Repetition

of

of the ſame Work; which is ſo obvious, that an Example is needleſs.

How (by the Chain *only) to take the true* Plot *of an irregular* Field, *conſiſting of many* Sides *and* Angles: *And how to make a perfect* Draught *of the ſame, upon* Paper *or* Parchment.

LET A B C D E F G H I K L Q R, (*Fig.* 3.) be an *irregular Field*, to be *meaſured* by the *Chain* only.

1. At your firſt Entrance into the Field, cauſe *Beacons* or other *viſible Marks* to be ſet up at (or as near as you can to) all the principal *Angles* or *Corners* thereof: As thoſe at M, N, O and P.

2. Conſider the fitteſt, or moſt convenient Corner to begin at (altho' any will ſerve) as I have here done with the *Beacon* or *Mark* at O.

3. Then laying one End of the *Chain* to the *Beacon* at O, meaſure out two *Chains* (more or leſs, as you ſee Occaſion) from the *Beacon* at O, towards the *Beacon* at P, and at the End of two *Chains* (or other Meaſure) ſtick up a ſmall Mark or Stick, as at the Mark * in the Figure. Again, from your Beacon at O, meaſure out two *Chains 45 Links* (or other Meaſure) from the Beacon at O, towards the Beacon at N, and there ſet up another ſmall Stick or Mark as at † in the Figure: And then, meaſure with your Chain, the Diſtance between the two Sticks or Marks at * and †, which ſuppoſe to be 2 Chains 91 Links.

4. Prepare a *Book*, or *Sheet* of *Paper*, ruled as is done in the *Margin* hereof, to ſet down your *Meaſures* as you go about the Field. But firſt (at the Top of the *Book* or *Paper*, make a *Triangle* anſwerable to that which you meaſured out upon the Ground in the Field, (as *Fig.* 2.) and ſet ſuch *Numbers*, *Letters*, and *Marks* to it, as you there meaſured, and deſigned to know them by, even as you ſee in *Fig.* 2.

Sets off	Ch.	L.	Sets off
0 30	0	00	
0 70	1	40	
0 50	3	40	
1 20	6	50	
0 40	7	20	
0 70	0	00	
Touch	2	10	
0 90	3	35	
0 40	4	80	
1 10	5	50	
0 25	0	00	
6 50	1	80	0 70
	3	00	a Con-
Touch	4	25	duit-
0 40	6	50	Head.
	0	00	0 00
	2	70	2 70
	5	90	5 90

This done, begin your Work at your Beacon at O, and meaſure the Diſtance of it from the Hedge on your left-hand, and finding it to be 30 Links of your Chain; ſet down 30 Links on the left-hand Column of your Book, againſt 0 Ch. 00 Links (or at the beginning of your Meaſure) becauſe the Hedge was on your left-hand.

Then with your Chain, meaſure from the Beacon at O, towards the Beacon at P, in a right Line: And as you go along, at the end of 1 Ch. 40 L. you find a *Break* or *Bend* in the *Hedge*, which is diſtant from your Chain Line 70 Links. Set down the 1 Ch. 40 L. in the *Middle Column*, and the 70 Lin. againſt it, in the *Left-hand Column* of

the Table. Then going on farther towards P, at the end of 3 Ch. 40 Lin. you come againſt another *Break* or *Bow* in the *Hedge*, which is diſtant from your *Chain-Line* 50 Lin. both which ſet down in your Book or Paper in their reſpective *Columns*. And going on farther (in a ſtreight Line) towards P; at the End of 6 Ch. 50 Lin. I find another *Break* or *Bow*, which is diſtant from your *Chain Line* 1 Ch. 20 L. both which ſet down in their reſpective *Columns*: And ſo meaſure on to your Beacon at P, which will terminate at the end of 7 Ch. 20 L. this ſet down in the middle Column: And becauſe the Beacon at P, is 40 Lin. diſtant from the Hedge, ſet 40 Lin. in the Left-hand Column, againſt 7 Ch. 20 Lin. in the middle Column: And then draw a Line croſs your Book or Paper, to ſignify, that you have done with that *Side* of the *Field*.

Then, in your ſtook, in the middle *Column*, under Ch. Lin. write 0 00. And becauſe the Beacon at P, is diſtant from the Hedge on your Left-hand 70 Lin. ſet 70 Lin. in the Left-hand Column of the Table, againſt 0 00; then go on, and meaſure towards the Beacon at M, and meaſuring on, at the end of 2 Ch. 10 Lin. you find that the Chain Line juſt touches the Corner, or Bow of the Hedge; wherefore, ſet down 2 Ch. 10 Lin. in the middle Column, and againſt it in the Left-hand Column write *Touch*. And meaſuring on farther towards M, at the end of 3 Ch. 35 Lin. I find another Bow in the Hedge, diſtant from the Chain Line 90 Lin. both which ſet down in their proper Columns: And meaſuring on farther, againſt 4 Ch. 80 Lin. I find another Bow, diſtant from the Chain Line 40 Lin. both which ſet down. Then meaſuring on to your Beacon at M, you find the Length to be 5 Chains 50 Lin. which ſet down in the middle Column; and becauſe the Beacon at M, is diſtant from the Chain Line 1 Ch. 10 Links, ſet 1 Ch. 10 L. in the Left-hand Column againſt 5 Ch. 50 Lin. And thus having finiſhed this Side of the Field; and therefore draw a Line croſs your Book, as before.

In this manner muſt you deal with the other two Sides (and Chain Lines M N and N O) in the Field, and ſet the ſeveral Diſtances at every Bend, and the Diſtance of every Bend from the Chain Line, as you ſee is done here in this Table.

And thus, having ſhew'd you how to meaſure ſuch an irregular Piece of Ground (as to the Work in the Field) it reſteth now to ſhew you how to make a true *Plot* or *Figure* thereof upon *Paper* or *Vellom*, in order to the finding of the *Content* or *Quantity* of the Field, in *Acres*, *Roods* and *Perches*.

How to Protract, *or lay down upon* Paper *any irregular* Piece *of Ground, meaſured by the* Chain *only, as in the foregoing* Work.

Firſt, Upon a Sheet of good ſtrong Paper, draw a right Line at pleaſure, towards one end whereof, aſſume a Point, as at O, (*Fig.* 3.) repreſenting the place where you ſet up your firſt *Beacon*.

Second-

Secondly, With your Compaſſes, from any *Scale* of *equal Parts*, take out two Chains, and ſet them upon the Line before drawn, from O to *; alſo, out of the ſame Scale, take two Chains 91 Links, and ſetting one Foot of the Compaſſes in the Point *, with the other Foot deſcribe an obſcure Arch of a Circle z z: And then, take two Chains 45 Lin. from the ſame Scale; and ſetting one Foot of the Compaſſes in O, with the other deſcribe another obſcure Arch * +, cutting the former Arch in the Point T, through which Point draw the right Line O T N at pleaſure: And now you have upon your *Paper* a *Triangle*, like in all reſpect to that which you meaſured out in the Field, and agreeable alſo with that at the *Top* of your *Book* or *Paper*.

Thirdly, Lay your Book or Table before you, by which you ſhall find that your firſt *Chain Line* did contain 7 Chains 20 Lin. wherefore take 7 Ch. 20 Lin. from your Scale, and ſet them from O to P, ſo is P the Place of your ſecond *Beacon*. Again, by your Book you find, that the Diſtance between your firſt *Beacon* at O, and your laſt at N, was 5 Ch. 90 Lin. Take 5 Ch. 90 Lin. from your Scale, and ſet them upon the Line O T N, from O to N, ſo is N the place of your laſt *Beacon*. And now, finding by your Book, that your ſecond Station (or Chain Line) doth contain 5 C. 50 L. take that Length out of your Scale, and ſetting one Foot of the Compaſſes in P, with the other deſcribe the obſcure Arch S S: And the Length of your third *Chain Line*, being 6 Ch. 50 Lin. take 6 Ch. 50 Lin. from your Scale, and ſetting one Foot in N, with the other Foot deſcribe the obſcure Arch V V, croſſing the former Arch S S, in the Point M, which is the Point for your third *Beacon*: And thus have you drawn upon your Paper, your four *Chain Lines*, making the *Quadrilateral Figure* or *Trapezian* M N O P.

Fourthly, Having gone thus far, you muſt have recourſe to your Book again, and there finding, that at your beginning at O, your Beacon at O, did ſtand 30 Links diſtant from the Hedge; take 30 Lin. from your Scale, and ſet them from O to *n*. Alſo, at the end of 1 Ch. 40 Lin. at *a*, the Bow of the Hedge was diſtant from the Chain Line 70 Lin. From your Scale, take firſt 1 Ch. 40 Lin. and ſet them from O to *a*, and the 70 Lin. from *a* to B, and then draw the Line *n* B, extending it to A. Then take 3 Ch. 40 Lin. and ſet them from O to *b*, and 50 Lin. from *b* to C; and draw the Line B C. Then take 6 Ch. 50 Lin. and ſet them from O to *c*, and 1 Ch. 20 Lin. and ſet them from *c* to D. and draw the Line C D. Then at 7 Ch. 20 L. which is at the Beacon at P, ſet 40 Lin. to the Hedge at *q*, and through that Point draw the Line D *q*, extending it to E. And thus is this *firſt Side* of your *Field* finiſhed.

Fifthly, Begin again at the Beacon at P, where you find by your Book, that the Beacon was diſtant from the Hedge 70 Lin. ſet 70 Lin. from P to E, and draw the Lin. D *q* E. Then at 2 Ch. 10 Lin. you find that your *Chain Line* did touch the *Bow* of the Hedge; wherefore, take 2 Ch. 10 Lin. from your Scale, and ſet them from P to F, (or *d*) and draw the Line E F. In like manner, you find that

that at 3 Ch. 35 Lin. the Bow of the Hedge was distant from the Chain Line 90 Links; Set the 3 Ch. 35 L. from P to *e*, and the 90 Lin. from *e* to G, and draw the Line F G. Then your next Length 4 Ch. 80 Lin. will reach from P to *f*, where the *Bend* of the *Hedge* is distant from the Chain Line, 40 Lin. Set the 4 Chains 80 Lin. from P to *f*, and the 80 Lin. from *f* to H, and draw the *Line* G H. Then your last Length 5 Ch. 50 Lin. will reach from P to M, where the *Beacon* at M is distant from the Hedge 1 Chain 10 Links, set the 1 Ch. 10 Lin. from M to I, and draw the Line H G.

Thus have you finished your second Side, and in the same manner must you deal with the other two Sides; and in so doing, you shall have the true Plot of the *irregular* Piece of *Ground* upon your *Paper*, which you may cast up in *Acres*, *Roods* and *Perches*, by the *Directions* given in this Book.

How to take the Plot *of a* Wood (*into which you cannot come to measure*) *by going round about the same, by the* Chain *only: And to make a* Plot *thereof upon* Paper *or* Vellom.

LET W (*Fig.* 4.) be such an irregular Piece to be measured and plotted.

1. Go about the same, and as near as you can to the Hedges Sides that inclose the Wood; and at all eminent Turnings or Corners thereof, set up *Marks* or *Beacons*, as at A, B, C, D and E. Then,

1. At the *Beacon* B, measure out 2 Chains (or any other Measure) from B towards A, and also, towards C; to the *Marks* ☿ and ☉; and also measure the Distance between those two *Marks*.

2. Also, measure the *Beacon* at C, measure out towards the *Beacons* at B and D, 2 Chains (or other Measure) as at the *Marks* ♀ and ♂, together with the Distance between those two *Marks*. And then,

3. Having prepared a *Field Book* ruled like this in the Margin. Begin to measure as followeth, *viz.*

1. From A towards B, where the *Beacon* at A stands 75 Links from the Hedge of the Wood, wherefore, against 0 Chains 00 Links (in the middle Column of your *Field Book*) set 75 Links in the Left-hand Column, because the Hedge was on your Left-hand. Then, measuring on in a right Line towards B, where, at 0 Ch. 50 Links, your *Chain Line* is distant from the Hedge 60 Links; set down 0 Ch. 50 Lin. in the middle Column, and against it 60 Lin. in the *Left-hand Column*. Then,

Measuring on farther towards the *Beacon* at B, you find that at	1 Ch. 05 Links	Your Chain-line is distant from the Hedge	0 C. 50 L.		
	1 75		0 30		
	3 40		0 75		
	4 30		0 25		

All

All which ſet down in your Field Book, as you ſee done in the Preſident in the Margin.

2. And now being arriv'd to your *Beacon* at B, make in your Field Book a Triangle, like unto that which you ſet out in the Field at the *Beacon* B, ſetting to it the ſame Meaſures as you there meaſured, and as you ſee is done in (*Fig.* 5.) And then,

3. Begin to meaſure from B (in a right Line) towards C, and meaſuring along, you ſhall find,

That at { 1 Ch. 55 L. / 3 15 / 6 70 / 8 35 } The Hedge is diſtant from your Cha. Lin. { 0 Ch. 50 Lin. / 0 65 / 0 00 / 1 00 }

All which ſet down in your Field Book, and being come to your *Beacon* at C, make there a Triangle, like unto that which you ſet out in the Field, ſetting the like Marks and Numbers to it, as is done in (*Fig.* 6.) And then,

4. Begin to meaſure from the *Beacon* at C, towards that at D in a right Line; and in your meaſuring along, you ſhall find,

That at { 2 Ch. 30 Lin. / 4 30 } The Hedge is diſtant from your Ch. L. { 0 C. 25 L. / 0 55 }

All which ſet down in your Field Book: And then,

5. Begin to meaſure from the *Beacon* at D, towards that at E, where you find,

That at { 0 Ch. 65 / 2 35 / 3 50 / 4 90 } The Hedge is diſtant from your Chain Line, { 0 C. 60 L. / 0 35 / 2 35 / 0 60 }

All which you muſt ſet down in your Field; and ſo proceed.

6. Meaſure from the *Beacon* at E, to the *Beacon* at A, where you began; and in your Progreſs you find,

That at { 1 Ch. 75 L. / 2 35 / 5 10 / 7 15 / 7 55 / 8 10 } The Hedge is diſtant from your Chain Line, { 0 C. 55 L. / 0 00 / 0 60 / 0 40 / 0 25 / 0 35 }

Field Book.

Sets off	C	L	
0	75	0	00
0	60	0	50
0	50	1	05
0	30	1	75
0	75	3	40
0	25	4	80
0	00	7	15
0	00	0	00
0	50	1	55
0	65	3	15
Touch		6	70
1	0	8	35
0	00	10	0
0	00	0	00
0	25	2	30
0	55	4	30
0	00	4	80
0	00	0	00
0	60	0	65
0	35	2	35
1	35	3	50
0	60	4	90
0	00	7	20
0	00	0	00
0	55	1	75
Touch		2	85
0	60	5	10
0	40	7	15
0	25	7	55
0	35	8	10
0	00	9	30

From A to B. From B to C. From C to D. From D to E. From E to A.

All which ſet down in your Field Book, in the Order as you ſee them ſet in the Exemplary Table in the Margin.

And thus having finiſhed your Work in the Field, you may proceed to *Protract*, or lay the ſame down upon Paper, and make a fair *Plot* thereof, as followeth.

How to Protract, *and make a fair Draught or* Plot *of the* Wood *before meaſured.*

BEING provided with a Sheet of Paper or Parchment, upon it draw a right Line at pleaſure; and laying your Field Book before you, therein you will find, that from your *firſt Beacon* at A, to your *ſecond Beacon* at B, there was contained 7 Chains 15 Links: Therefore,

1. Take 7 Ch. 15 L. from your Scale, and prick that Diſtance down (upon your Line before drawn) from A to B: And becauſe the *Beacon* at A was diſtant from the Hedge 75 L. Take 75 L. from your Scale, and ſet them from A to 1. Then, at o C. 50 L. from A, the Hedge is diſtant from the Chain Line 60 L. therefore take the 50 L. and ſet them from A to *a*, and the 60 L. from *a* to 2. Then,

At	1 C. 05 L.		at	b	The Hedge	0 C. 50	Set	b	3
	1 75			c	is diſtant	0 30	which	c	4
	3 40			d	from the	0 75	from	d to	5
	4 80			e	Ch. Lin.	0 25		e	6

And draw the Lines 1. 2. 2. 3 3. 4 4. 5 and 5 6. And ſo have you finiſhed that Side of the *Wood* that lies againſt the Chain Line A B. Then,

2. When you come to your *Beacon* at B, have recourſe to your Field Book, and upon B make a Triangle equal to that you meaſured out in the Field, by ſetting 2 C. 00 L. from B to ☉, and from B to ☿, and 2 Ch. 50 L. from ☉ to ☿, and drawing the Line B ☿ C, which by your Book you will find to contain 10 Chains. Then,

3. Going from B towards C; you will find by your Field Book, That

At	1 C. 85 L.		at	f	The Hedge is	0 C. 50 L.	ſet	f to	7
	3 15			g	diſtant from	0 65	which	g to	8
	6 70			h	the Chain-	0 00	from	h to	9
	8 35			i	line.	1 00		i to	10

And draw the Lines 6.7 7.8 8.9 9.10, ſo ſhall you have protracted that Part of the Wood, which lies againſt your Chain Line B C. And then,

4. When

4. When you come to your *Beacon* at C, having recourse to your Field Book again; upon the Point C make a Triangle equal to that which you measured out in the Field, by setting 2 Ch. 00 L, from C to * upon the Line B C, and from C to δ upon the Line C D, with the Distance of 1 Ch. 30 L. between them, and through the Point δ draw the Line C D, which (by your Field Book) contains 4 Ch. 50 L. And then,

5. Measuring from you *Beacon* at B, towards the *Beacon* at D, you will find by your Field-book, That

At		at		The Hedge was		set which	
2 C. 30 L.		*k*	dist. from C. L.	0 C 25 L.		*k* to 11
4 80		*l*		0 55	from	*l* to 12

And draw the Lines 10. 11 and 11. 12, so shall you have protracted that Part of the Wood which lies against the Chain Line C D.

6. When you come to the *Beacon* at D, look for the Length of your next Chain-line from D to E, which you will find to contain 7 Ch. 20 L. which take in your Compasses, and setting one Foot in D, with the other Foot describe the obscure Arch H H: Also, the Length of your Chain-line from the *Beacon* at E, to the first *Beacon* at A, you find to be 9 Ch. 30 L. which also take out of your Scale, and setting one Foot of the Compasses in A, with the other describe the obscure Arch K K, crossing the other Arch in the Point E; and then draw the two Lines D E and A E; and so are all your Chain-lines *protracted.* And then,

7. You will find by your Field Book, that in measuring from D to E, you found that

At		at		The Hedge		Set	
0 C. 65 L.		*m*	was distant	0 C. 60 L.		*m* to 13
2 35		*n*		0 35		*n* to 14
3 50		*o*	from the	1 35	which from	*o* to 15
4 90		*p*	Ch. Line.	0 60		*p* to 16

And draw the Lines 13.14 14.15 15.16. And so you have protracted that Part which lies against your Chain-line between D and E.

8. *Lastly*, In measuring from the *Beacon* at E, to the *first Beacon* at A, you do find by your Field Book, That

At		at		The Hedge		Set	
1 C. 75 L.		*q*		0 C. 55 L.		*q* to 17
2 85		*r*	was distant	0 00		*r* to 18
5 10		*s*		0 60		*s* to 19
7 15		*t*	from the	0 40	which from	*t* to 20
7 55		*u*	Chain-line,	0 25		*u* to 21
8 10		*x*		0 35		*x* to 22

And then draw the Lines 16.17 17.18 18.19 19.20. 20.21 21.22 And so is your *Protraction* ended: The form of the Wood being as in the Figure.

In

In the caſting up whereof, you muſt firſt find the Content of the whole Figure made by the Chain Lines A B, B C, D C, D E and E A: And afterwards, of the *Triangles* and *Trapezius* made by the *Off-ſets*; which being deducted from the Content of the *whole Figure* A B C D E, there will remain the *Area* or *Content* of the *Wood* only.

Several Errors in Meaſuring of Land, *frequently practiſed (and too often truſted to) by the Vulgar, detected.*

I. SOME there are who ſay, *That if two Pieces of Land are of an equal Number of Poles, Perches* (or other Meaſure) *about; that thoſe two Pieces of Land do contain equal Quantities of Ground*; but this is evidently falſe:

For let the Piece of *Land* (*Fig.* 4.) which lies in a true Square Form, be every Side thereof 80 Perches; then four times 80 is 320, and ſo many Perches is that Piece of *Land* about: And 80 P. one of the Sides, being multiply'd in itſelf, that is, 80 by 80, the Product will be 6400 Perches, and that is the true *Content* of that Square Piece in Perches, which is juſt 40 Acres. Now there is another Piece of *Land* (*Fig.* 5.) which lies in a Square Form alſo (all the Angles of it being Right (or Square) Angles;) but the Length thereof is 110 P. and the Breadth 50 P. now this Piece of Ground is as much about as the other; for twice 110, and twice 50 added together, makes 320: But, if you multiply 110 the Length, by 50 the Breadth, the Product will be but 5500 P. which is leſs than the other by 900 Perches, that is, leſs by 5 Acres, 2 Roods and 20 Perches: Thus when both the Figures are Square (or right angled;) but if a Piece of the ſame Length in the Sides, and of the ſame Breadth at the Ends, ſhould lie in ſuch Form as the Figure 6, where two Angles are *Obtuſe*, and two *Acute*, the Difference will be then greater; for ſuch a Piece is not meaſured by multiplying the Length by the Breadth, but by the Length of the longeſt Side by the deepeſt Diſtance between thoſe Sides, which is here but 32 P. So that 110 the Length, multiplied by 32, that Diſtance, produceth but 3520 Perches, which is leſs than the firſt by 2880 P. or 18 Acres.

Again farther: Let the irregular Piece of Ground D E F G H, (*Fig.* 7.) whoſe Sides are D E 57 Perches, E F 85 Perches, F G 72 Perches, G H 40 Perches, H D 60 P. all which added together, make 320 Perches for the Compaſs of the whole Figure, equal to the Number of Perches about the Square A: Now this Figure being caſt up, the Superficial Content thereof will be found to be

be 5450 Perches, which is leſs than the perfect Square Figure A, by 950 Perches, and leſs than the long Squre B by 50 Perches only; and greater than the Figure C by 1980 Perches. By theſe Preſidents you may ſee that the nearer any right-lined Figure comes to a regular Polygon, the more capacious it is; for of all right-lined Figures, the regular Polygon is the moſt capacious: But if there were a circular Piece of *Land*, the Circumference whereof were 320 Perches about, as (*Fig.* 8.) equal to the Meaſure of the Square A about: Such a Circle will be found to contain 8142 Perches, which is more than the Content of the Geometrical Square A, by 1742 Perches; for of all Plain Figures whatſoever, the Circle is the moſt capacious.

But before I leave the Confutation of this Error, let us take again a View of the irregular Figure laſt treated of, *viz.* D E F G H: Which we found to contain 5450 Perches, the Compaſs whereof about was 320, equal to the Square A. But now ſuppoſe the Sides or Hedges D E, E F, and F G, to be in the ſame Form as they are drawn in the Figure; but the Hedge G H, may as well turn inwards to *h*, and the Hedge D H inwards alſo to *h*, and yet retain their ſame Lengths; but making another kind of Figure, namely, D E F G h D, equal about to the Figure D E F G H D, but leſſer by the Quantity of the ſhadowed Piece D H G h, which contains 209 Perches. This needs no farther Proof.

II. Another Error frequently practiſed in meaſuring of Ground (eſpecially, for Ploughing, Sowing, Mowing, Reaping, &c) is this: That, *if a Piece of Ground conſiſting of four Sides* (how unequal ſoever they be,) *if you add the two oppoſite Sides one to the other, and take their Halves, thoſe two Halves multiplied together, ſhall be the true Content of that Piece of Ground.*

Others there are that ſay;

If in a Four-ſided Piece of Ground, you meaſure croſs the Field from the Middle of one Side, to the Middle of the other Side, both Ways, that thoſe two Lengths multiplied into each other, ſhall give the true Content of that Piece.

Both which Errors, I thus detect. Let there be a Piece of Land of Four unequal Sides, as O P Q R: (*Fig.* 9.) Which Piece, if truly meaſured, will be found to contain 13017 Perches, that is, 81 Acres, 1 Rood, and 17 Perches.

Now, the Side P Q is 40 Perches, the Side O R (oppoſite to it,) is 164 Perches; theſe added together make 204 Perches, the half whereof is 102 Perches. Again; the Side P O is 220 Perches,

ches, and the oppoſite Side Q R 108 Perches, which added together make 328 Perches, the half whereof is 164 Perches. Now theſe two Halves 164 and 102 multiplied together, do make 16728 Perches greater than the true Content by 3711 Perches; Or 23 Acres and 31 Perches: And thus is the Firſt of theſe Errors detected: Now for the Second.

A Length meaſured from the Middle of the Side P Q, to the Middle of the oppoſite Side O R, will be found to contain 156 Perches: And the Length meaſured from the Middle of the Side P O, to the Middle of the oppoſite Side Q R, will be found to be 96 Perches: Theſe multiplied into each other, do produce 14976 Perches for the Content, which is more than the true Content by 1959 Perches, or 12 Acres and a Quarter; yet leſs than the former erroneous Way by almoſt half: But by both theſe Ways, it always makes the Content of the Ground greater than it ſhould be, and therefore ought to be rejected.

Thee End of the Sixth Book.

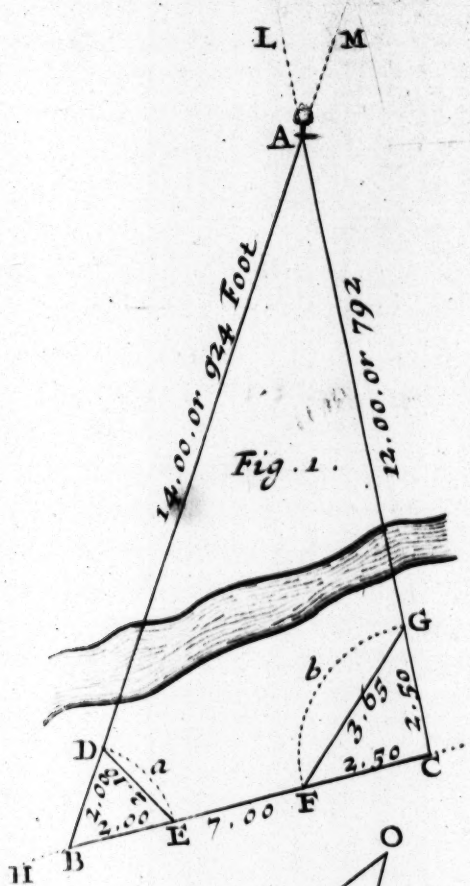


Fig. 1.

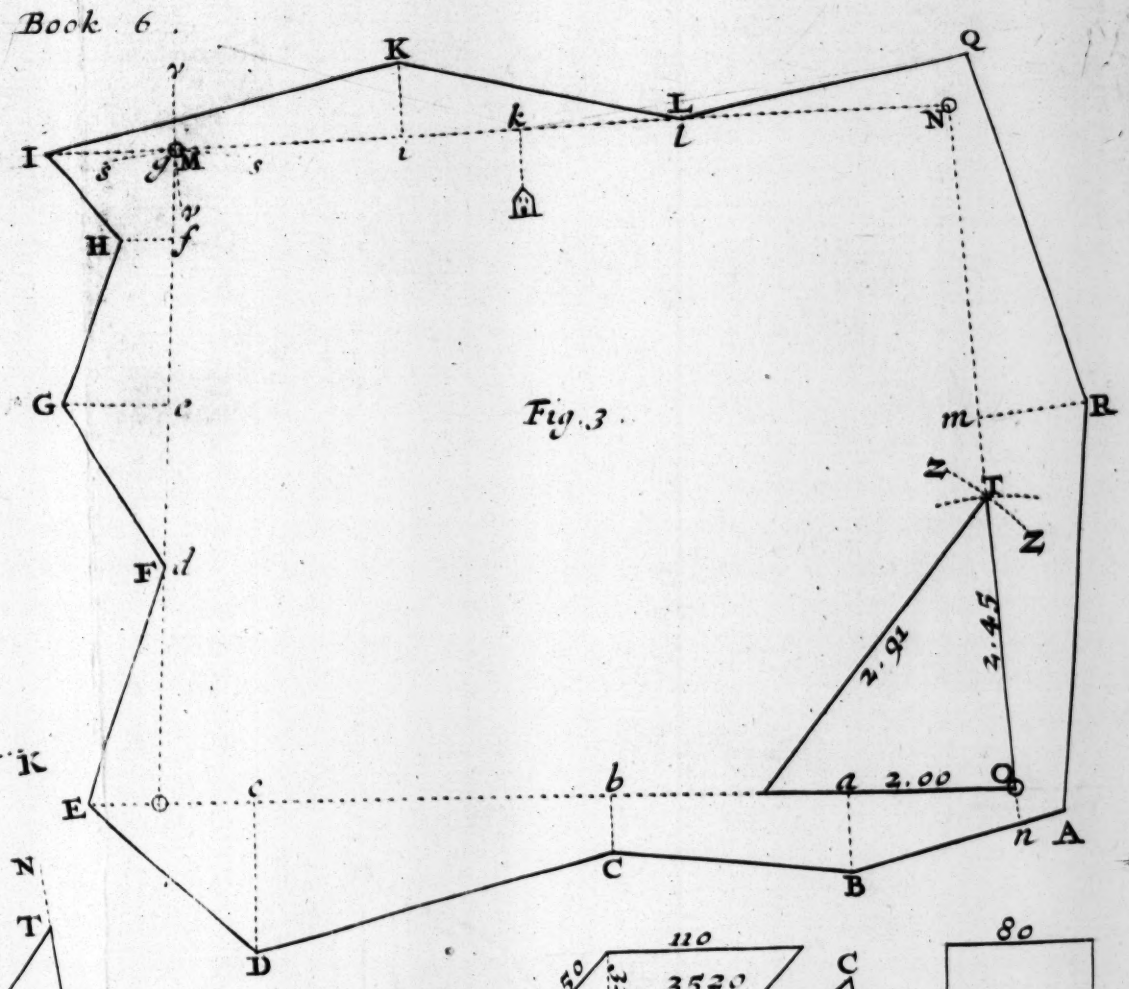
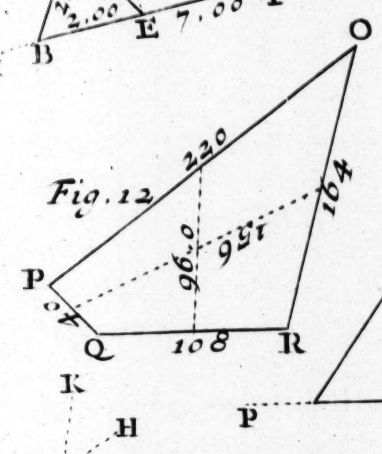
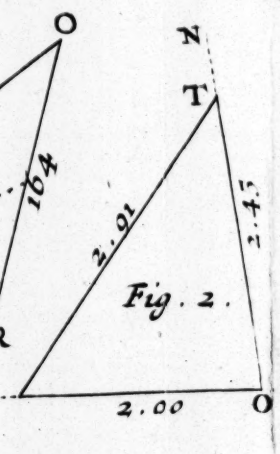


Fig. 3.





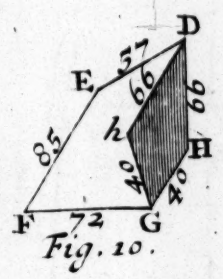
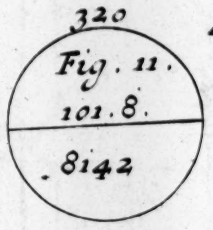


Fig. 10.



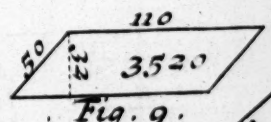


Fig. 9.

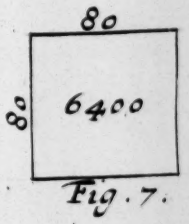
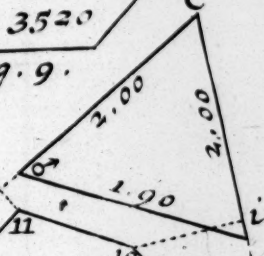


Fig. 7.



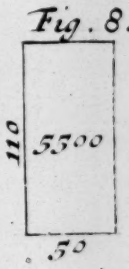


Fig. 8.

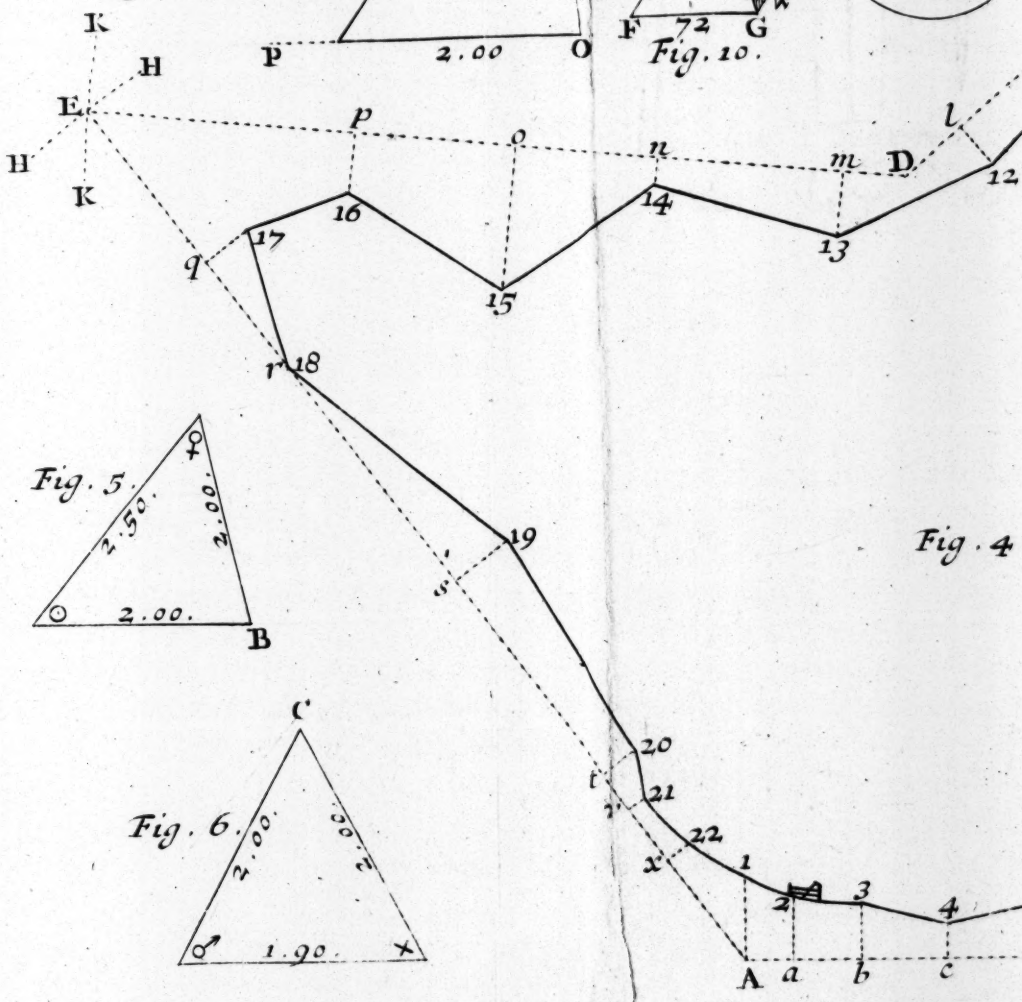


Fig. 4.

Fig. 5.

Fig. 6.

The COMPLEAT SURVEYOR.

The Seventh Book.

The *ARGUMENT.*

Having in the foregoing Books *largely treated of the* Surveying *of all manner of* Grounds, *whether* Wood-Land, Champion, or other *Grounds, either* Plain, *or* Mountainous, *divers* Ways, *and by several* Inſtruments, *I conceived it very neceſſary (to the compleating of this* Treatiſe) *to ſay ſomething concerning other kinds of* Menſurations, *and could think of none more convenient, than ſuch as concern* Building, *and* Materials *thereunto belonging; conſidering that* Gentlemen *and* Others, *have continual occaſion either to* buy *or* ſell Timber, Stone, *and other* Neceſſaries *for that purpoſe; and how that ſome in the* purcha-

ſing, *and others in the* ſelling *of ſuch* Materials, *are daily abuſed; partly out of ill* Cuſtoms *(too frequently in uſe) but principally for the want of* Geometrical Knowledge *in ſuch as undertake for themſelves, or are intruſted by others, in ſuch* Employments. *For,* Errors *in many Caſes are committed inſenſibly; and the* Undertaker, *for want of Skill in* Geometry, *knows not whence ſuch* Errors *do ariſe, nor how to rectify or amend the ſame when they are introduced. I have therefore, in this Seventh Book, laid down ſuch* plain, eaſy, *and* infallible Rules *(all grounded upon firm Geometrical Principles) for the* Menſuration *of* Superficies *and* Solids, *as* Board, Glaſs, Pavement, Wainſcot, Plaiſtering, Painting, Brick-work, &c. *Likewiſe of* Solids, *as* Stone, Timber growing, or ſquared, *&c. And for the* Eaſe *and* Benefit *of ſuch as have not Skill, or at leaſt Leiſure to pry far into this kind of Learning, I have for their Sakes (beſides the Ways and Means whereby theſe* Menſurations *are to be performed) calculated* Tables *wherein all (or the moſt part) of the foremention'd Particulars are* ready caſt up *to Hand, ſo that if you have but a* Rod, *or* Rule *to take your* Dimenſions *with, you may come very near the Truth of the Thing you deſire to know. There are divers other things promiſcuouſly inſerted in this Seventh Book which are not here enumerated, but thoſe I leave to the Scrutiny of the Peruſer.*

OF

OF

MEASURING.

CHAP. I.

Of Superficial Measures *in general*; *But more particularly of the* Menſuration *of* Board, Glaſs, Pavement, Wainſcot, Plaiſtering, Painting, Tiling, *&c.*

1. BOard, *Glaſs*, and ſome other ſorts of Superficies, as *Pavement* of *Marble*, or *Purbeck* Stone is commonly meaſur'd by the *Foot Square*, that is, 12 Inches every way, which is in all 144 Inches.

2. *Wainſcoting*, *Plaiſtering*, and *Painting*, are meaſured by the *Yard Square*, that is 3 Foot every way, which is in all 9 ſquare Feet.

3. *Tiling*, *Flooring*, and *Roofing* by the *Square of Ten*; that is ten Foot every way, in all, (or in each *Square*) 100 ſquare Feet.

4. *Brick-work* is meaſured by the *Rod Square* of 16 Foot and an half, each *Rod* containing 272 and a quarter of *ſquare Feet*.

Now to ſhew the manner of meaſuring any of the above-mentioned, by help of the Table of *Logarithms* in the third Book, as alſo by the *Line of Numbers*, it were moſt ſuitable to have your *Rule* by which you meaſure, whether it be *Foot*, *Yard*, *Rod*, or *Perch*, divided into 10, 100, or 1000 Parts, according to the length thereof, that way of diviſion being moſt agreeable both to the *Tables*, and alſo to the diviſions of the Line of Numbers. Theſe things being premiſed, I ſhall now come to give *Examples* in each of theſe ſorts of Works.

CHAP. II.

Of Foot Meaſure.

I. *A Board being* 1 *Foot and* 25 *parts broad, and* 16 *Foot and a half, which is five tenths of a Foot long, how many ſquare Feet are contained therein?*

I Might here ſhew how to perform this, and all ſuch-like Concluſions, as I have before mentioned, by the help of the *Table* of

of *Logarithms* in the third Book, but the *Tables* there being so short, going only to 1000, they are unfit for this Business, without many Cautions to be observed in the Use of them; which, in this place, to enumerate would be both tedious and troublesome to the Learner; especially when the Dimensions consist of *whole Feet* and *parts of Feet*, or *whole Yards* and *parts of Yards*, and the like; but when they consist of *Integers* or whole Numbers only, and when the Product doth not exceed 1000, then the Tables will exactly and easily perform the *Work*, as in this *Example*.

II. *If a Free-Stone Pavement should contain* 52 *Foot in length, and* 16 *Foot in breadth, how many square Feet are contained in that Pavement?*

By the Logarithms thus.

The Logarithm of 52 is	1,716003
The Logarithm of 16 is	1,204120
Their Sum is	2,920123

Which is the *Logarithm* of 832, and so many Square Feet is contained in that *Pavement*.

But if the *Pavement* had been 52 Foot and 5 parts long, and 16 Foot and 7 parts broad, then you could not come to so near an Exactness by these short Tables, because the sum of the two *Logarithms* cannot be their sum. And indeed in the setting down of the numbers of the *Characteristick* of the *Logarithms* should be varied; but this, with some other Cautions, in the use of *Logarithms*, are not convenient for this Place. Yet, for *Example* sake, so is the manner of working by the *Tables*.

The Logarithm of 52, 5 is	1,720159
The Logarithm of 16, 7 is	1,222716
Their Sum is	2,942875

The neareſt Number answering to this *Logarithm* in the Table is 877, but that is something too much, for the real Content of the Pavement is but 176 Foot and 75 parts of a Foot, which is three quarters of a Foot, as by the *Arithmetical Work* in the Margin doth appear; for 52, 5 being multiplied by 16, 7 giveth in the Product 876, 75, which is 876 whole *square Feet*, and 75 parts, or three quarters of a Foot.

52, 5
16, 7
3675
3150
525
87675

And for this Reason, the Table being something troublesome to such, who are not acquainted with the use of larger *Tables* of this Nature, I shall forbear to make farther Use of them in this kind, but

do all by the help of the *Line of Numbers*, which performeth all manner of *Menſurations* of this Nature, very expeditiouſly and exactly, as I have already made appear in my Treatiſe entituled, *The Uſe of the line of Proportion made eaſy*; and ſhall ſhew ſome farther *Uſes* thereof in a ſecond Part to the ſame Book, now almoſt ready for the Preſs; and as the *firſt Part* hath found good acceptance in the World, ſo I doubt not but the *ſecond Part* thereof will be as well received, for that it ſhall be furniſhed with variety of *Examples* continually in *Uſe* and *Practice* with (almoſt) all maner of *Artificers*, eſpecially ſuch as any way relate to *Building*, or in buying or ſelling *Materials* thereunto belonging But now to return to our intended Buſineſs.

III. *A Board being* 1 *Foot* 25 *parts broad, and* 16 *Foot and* 5 *parts (which is half a Foot) long, how many ſquare Feet are contained therein?*

As 1, is to 1, 25 the breadth,
So is 16, 5 the length, to 20, 62 the Content.

By the Line of Numbers.

Extend the Compaſſes from 1, to 1, 25. The ſame Extent will reach from 16, 5 to 20, 62 the *Content*. Or, if you extend the Compaſſes from 1, to 16, 5, the ſame extent will reach from 1, 25, to 20, 62, as before.

IV. *If a Plank be* 3 *Foot, and* 62 *parts broad, and* 23 *Foot* 75 *parts long, how many ſquare Feet doth it contain?*

As 1, is to 3, 62, the breadth,
So is 23, 75 the length, to 85, 97, the Content.

By the Line of Numbers.

Extend the Compaſſes from 1, to 3, 62. The ſame ſhall reach from 23, 75 to 85, 97, which is the quantity of Feet contained in that *Plank*, and is within 3 parts of an hundredth 86 Foot, and may be ſo called.

Or, if you extend the Compaſſes from 1, to 23, 75, the ſame will reach from 3, 62, to 85, 97, as before.

V. *If a Board or Plank be* 4 *Foot and* 50 *parts broad at one end, and* 3 *Foot* 20 *parts broad at the other end,* and 27 *Foot* 12 *parts long, how many Foot is contained therein?*

Becauſe the Breadths at either end are unequal, you ſhall therefore add both Ends together, and take the half thereof for a *mean breadth:* Thus 4, 50 and 3, 20 being added together, do make 7, 70, the half whereof is 3, 85, which is a *mean breadth.* Then,

As 1, is to 3, 85, the *mean breadth,*
So is 27, 12 the *length,* to 104, 41 the *content.*

By the Line of Numbers.

In this Caſe, if you extend your Compaſſes from 1, to 3, 85, the other Foot being placed in 27, 12 will reach beyond the Line. Wherefore (in ſuch Caſes)

Extend the Compaſſes from 1, in the middle of the Line, to 3, 85 downwards, towards the beginning of the Line, then will that ſame Extent reach from 27, 12 (downwards alſo) to 104, 41, which is the Content of the *Plank* or *Board.*

VI. *If a Pane of Glaſs be* 1 *Foot* 63 *parts broad, and* 2 *Foot* 8 *parts long, how many Foot are there in that Pane?*

As 1, is to 1, 63,
So is 2, 8, to 4, 56, the *Content.*

By the Line of Numbers.

Extend the Compaſſes from 1, to 1, 63. The ſame extent will reach from 2, 8 to 4, 56. Or extend the Compaſſes from 1, to 2, 8 the ſame will reach from 1, 63 to 4, 56 the Content, as before, which is 4 Foot and an half and three quarters of an Inch, in common Meaſure.

If many *Panes* of *Glaſs* ſtanding in the ſame range, that is, having all one height; with a *Line* or *String,* take all the breadths together in one ſum, and take that ſum for the length, and the height for the breadth. And then work as in the Example following.

VII. *Several* Panes of Glaſs *of different breadth, containing in length* 21 *Foot* 5 *parts, and being* 3 *Foot* 75 *parts high, how many Foot of* Glaſs *in all?*

As 1, is to 3,75, the common height,
So is 21, 5 all the breadths together
To 80, 62 the Content in Feet.

By the Line of Numbers.

Extend the Compaſſes from 1 to 3,75. The ſame extent will reach from 21, 5 to 80, 62 --- Or, extend the Compaſſes from 1 to 21, 5, the ſame will reach from 3, 75 to 80, 62 as before, which is 82 Foot, and ſomewhat above half a Foot, and ſo many Foot are in all the Panes.

VIII. *There is a* Yard *paved with* Free-ſtone, *being in length* 57 *Foot and* 5 *parts, and in breadth* 26 *and* 25 *parts, how many Foot are in that Yard.*

As 1 is to 26, 25 parts, the breadth,
So is 57,5 the length, to 1509, 37, the Content.

By the Line of Numbers.

Extend the Compaſſes from 1 in the middle of the Line downwards, to 26, 25. The ſame Extent will reach from 57, 5 downwards, to 1509, 37 the Content, which is both 1509 Foot, and about 5 Inches.

IX. *A* Marble Foot-pace, *being* 6 *Foot* 93 *parts long, and* 1 *Foot* 36 *parts broad, how many Foot therein?*

As 1 is to 1, 36 the breadth,
So is 6, 93 the length, to 9, 42 the quantity.

By the Line of Numbers.

Extend the Compaſſes from 1, to 1, 36. The ſame extent will reach from 6, 93 to 9, 42 the Content; ſo that there is 9 Foot and 5 Inches in that *Foot-pace.*

¶ Let theſe *Examples* ſuffice for things meaſured by the Foot ſquare, wherein, if the thing to be meaſured be broader at one End than at the other, obſerve the Direction given in the 3d Section of this Chapter. And now I will proceed to *Yard Meaſure*, as to things meaſured by the *Yard Square*, as *Wainſcot*,

ſcot, *Plaiſtering*, *Painting*, and other *Hangings*. But firſt (becauſe it is cuſtomary for Men to ſell parts, or a certain number of Feet of Board,) I will here ſhew you firſt, how by having the breadth of any Board or the like, given in *Foot-meaſure*, to find how much thereof in length will make a Foot ſquare, for which take this Example.

X. *A* Board *or any other* Superficies, *being* 72 *parts of a Foot broad, how much thereof in length will make a ſquare Foot?*

For the effecting hereof, the Proportion is,
As 72 Parts, the *breadth* in Foot-meaſure,
Is to 10, or 100, ſo is 1, in the middle of the Line,
to 1, 39 the *length* of ſo much of that Board
as will make a ſquare Foot.

By the Line of Numbers.

Extend the Compaſſes from 72 Parts, the *breadth*, to 1, in the middle of the Line, the ſame Extent will reach upwards from the ſame 1, to 1 Foot 39 parts, and ſo much in *length* will make a Foot ſquare of that Board.

¶ And now becauſe this way of Meaſuring is ſo cuſtomary, I will here inſert a Table, by which, (having the breadth of of any Board, or other Superficies given in Inches) you may find how much in length thereof will make a ſquare Foot, and that from one Inch broad, to 36 Inches, or 3 Foot broad.

A Table

A Table ſhewing how much in length of any Board, Plank, Pane of Glaſs, &c. will make a Foot ſquare; the breadth thereof being given in Feet and Inches, from one Inch to three Foot broad.

F. Inch	F.	Inc.	10 p. of Inc.		F. Inch	F.	Inc.	10 p. of Inc.		F. Inch	F.	Inc.	10 p. of Inc.	
0 1	12	0	0	0	1 0	1	0	0	0	11 0	0	6	0	0
2	6	0	0	0	1	0	11	8	0	1	0	5	8	0
3	4	0	0	0	2	0	10	3	0	2	0	5	5	0
4	3	0	0	0	3	0	9	6	0	3	0	5	3	0
5	2	4	0	0	4	0	9	0	0	4	0	5	1	0
6	2	0	8	0	5	0	8	5	0	5	0	5	0	0
7	1	8	0	0	6	0	7	8	0	6	0	4	8	0
8	1	6	0	0	7	0	7	2	0	7	0	4	7	0
9	1	4	0	0	8	0	6	8	0	8	0	4	5	0
10	1	2	0	0	9	0	6	3	0	9	0	4	4	0
11	1	1	0	0	10	0	5	10	0	10	0	4	2	0
12	1	0	0	0	11	0	5	6	0	11	0	4	1	0

Length of a Foot — Breadth of the Board, &c.

The Uſe of the TABLE.

Suppoſe a Board be 9 Inches broad, look in the Table for 9 Inches, and right againſt it you ſhall find 1 Foot and four Inches, and ſo much in length of the Board will make a ſquare Foot. So likewiſe, if a *Board* or *Pane* of *Glaſs* or *Marble Foot-pace*, be 1 Foot and 9 Inches broad, then 6 Inches and 8 tenth parts of an Inch will make a Foot ſquare.

CHAP. II.

Of Yard Meaſure.

IF the Yard with which you meaſure your Work be divided into 100 equal Parts, as your Foot before was, then will the Proportions be the ſame as in Foot-Meaſure, and the Work upon the *Line* of *Numbers* the ſame alſo; for the Compaſſes being extended from 1, to the breadth of the thing to be meaſured, the ſame extent of the Compaſſes ſhall reach from the Length thereof, to the Quantity of Yards therein contain'd: But if you meaſure by Feet and parts of a Foot, as before in Board-Meaſure, and would have your Reſult or Content in Yards, then the Proportion is

As 9 is to the Breadth,
So is the Length, to the Content in Yards.
Examples ſhall make this plain.

I. *A Piece of* Wainſcot *being* 8 *Yards, and* 82 *parts of a Yard deep, and* 10 *Yards and* 73 *parts broad, how many ſquare Yards are contained therein?*

As 1 is to 8, 183 depth,
So is 10, 73 the breadth,
To 94 Yards, 74 hundred parts of a Yard.

By the Line of Numbers.

Extend the Compaſſes from 1, to 8, 83, the depth. The ſame Extent will reach from 10, 73 the breadth, to 94, 74 the Content; ſo that there is 94 Yards and 3 Quarters contained in this piece of Wainſcot.

But if the Dimenſions of this piece of Wainſcot had been taken in Foot-Meaſure, the breadth would have been 26 Foot and 50 parts, and the depth 32 Foot and 20 parts, and then the Proportion would have been,

As 9 (the number of ſquare Feet in one Yard)
is to 26, 50 (the depth in Foot-Meaſure)
So is 32, 20 (the breadth in Foot-Meaſure)
To 94, 74, the Content in ſquare Yards.

By the Line of Numbers.

Extend the Compaſſes from 9, to 26, 50 the depth; the ſame Extent will reach from 32 20 the breadth, to 94, 74 as before, ſhewing that there is 94 Yards and 3 quarters contained in that Piece.

II. *A Cieling of a Room being* 97 *Foot and* 32 *parts broad, and* 120 *Foot long, how many Yards of Plaiſtering are contained in that Cieling?*

As 9 is to 97, 32 Feet,
So is 120 Feet to 1298 Yards.

By the Line of Numbers.

Extend the Compaſſes from 9 to 97, 32: The ſame Extent will reach from 120, to 1298, and ſo many Yards are contained in that Cieling.

III.

III. *A* Room *being* 8 *Foot* 50 *parts high, and* 92 *Foot about, how many Yards of Painting is there in this* Room?

Extend the Compaſſes from 9, to 92: The ſame Extent will reach fom 8, 50 to 868, 8, that is to 868 Yards, and 8 Foot. Or if by this manner of Working the Compaſſes open to too large an Extent you may extend them from 9, to 8, 50 downwards, and the Extent will reach from 92 downwards to 868, 8, as before.

IV. *A Piece of* Tapeſtry *being* 13 *Foot and* 25 *parts long, and* 7 *Foot* 36 *parts broad, how many Yards therein?*

As 9, to 13 25,
So is 7, 36 to 10,70 Yards.

Extend the Compaſſes from 9, to 13 25 parts: The ſame Extent will reach from 7 36, parts to 10, 70; ſo that there is 10 Yards and 7 Foot contained in that piece of Tapiſtry.

¶ Having given theſe *Examples* in *Yard-meaſure*, I will take the like Courſe as I did in *Foot-meaſure*, namely to add a *Table* by which you may know how many *Yards* are contained in any piece of *Work*, having the length and breadth thereof given in Feet, from 10 Foot broad to 30 Foot long.

A Table

A Table shewing how many square Yards are contained in any Piece of Work, the length and breadth being given in Feet.

The Breadth of the Plaistering, or other Work in Feet.

The Length of the Work in Feet.	1 Y F	2 Y F	3 Y F	4 Y F	5 Y F	6 Y F	7 Y F	8 Y F	9 Y F	10 Y F	11 Y F	12 Y F	13 Y F	14 Y F	15 Y F
1	0 1	0 2	0 3	0 4	0 5	0 7	0 7	0 8	1 0	1 1	1 2	1 3	1 4	1 5	1 6
2	0 2	0 4	0 6	0 8	1 1	1 3	1 5	1 7	2 0	2 2	2 4	2 6	2 8	3 1	3 3
3	0 3	0 6	1 0	1 3	1 6	2 0	2 3	2 6	3 0	3 3	3 6	4 0	4 3	4 6	5 0
4	0 4	0 8	1 3	1 7	2 2	2 6	3 1	3 5	4 0	4 4	4 8	5 3	5 7	6 2	6 6
5	0 5	1 1	1 6	2 2	2 7	3 3	3 8	4 4	5 0	5 5	6 1	6 6	7 2	7 7	8 3
6	0 6	1 3	2 0	2 6	3 3	4 0	4 6	5 3	6 0	6 6	7 3	8 0	8 6	9 3	10 0
7	0 7	1 5	2 3	3 1	3 8	4 6	5 4	6 2	7 0	7 8	8 5	9 3	10 1	10 8	11 6
8	0 8	1 7	2 6	3 5	4 4	5 3	6 2	7 1	8 0	8 8	9 7	10 6	11 5	12 4	13 3
9	0 9	1 2	0 3	0 4	0 5	0 6	0 7	0 8	0 9	0 10	0 11	0 12	0 13	0 14	0 15
10	1 0	1 2	2 3	3 4	4 5	5 6	6 7	7 8	8 10	0 11	1 12	2 13	3 14	4 15	5 16
11	1 2	2 4	3 6	4 8	6 1	7 3	8 5	9 7	11 0	12 2	13 4	14 6	16 8	17 1	18 3
12	1 3	2 6	4 0	5 3	6 6	8 0	9 3	10 6	12 0	13 3	14 6	16 0	18 3	18 6	20 0
13	1 4	2 8	4 3	5 7	7 2	8 6	10 1	11 5	13 0	14 4	15 8	17 3	19 7	20 2	21 6
14	1 5	3 1	4 6	6 2	7 7	9 3	10 8	12 4	14 0	15 5	17 1	18 6	21 2	21 7	23 3
15	1 6	3 3	5 0	6 6	8 3	10 0	11 6	13 3	15 0	16 6	18 3	20 0	22 6	23 3	25 0
16	1 7	3 5	5 3	7 1	8 8	10 6	12 4	14 2	16 0	17 7	19 5	21 3	24 1	24 8	26 6
17	1 8	3 7	5 6	7 5	9 4	11 3	13 2	15 1	17 0	18 8	20 7	22 6	25 5	26 4	28 3
18	2 0	4 0	6 0	8 0	10 0	12 0	14 0	16 0	18 0	20 0	22 0	24 0	26 0	28 0	30 0
19	2 1	4 2	6 3	8 4	10 5	12 6	14 7	16 8	19 0	21 1	23 2	25 3	27 4	29 5	31 6
20	2 2	4 4	6 6	8 8	11 1	13 3	15 5	17 7	20 0	22 2	24 4	26 6	28 8	31 1	33 3
21	2 3	4 6	7 0	9 3	11 6	14 0	16 3	18 6	21 0	23 3	25 6	28 0	30 3	32 6	35 0
22	2 4	4 8	7 3	9 7	12 2	14 6	17 1	19 5	22 0	24 4	26 8	29 3	31 7	34 2	36 6
23	2 5	5 1	7 6	10 2	12 7	15 3	17 8	20 4	23 0	25 5	28 1	30 6	33 2	35 7	38 3
24	2 6	5 3	8 0	10 6	13 3	16 0	18 6	21 3	24 0	26 6	29 3	32 0	34 6	37 3	40 0
25	2 7	5 5	8 3	11 1	13 8	16 6	19 4	22 2	25 0	27 7	30 5	33 3	36 1	38 8	41 6
26	2 8	5 7	8 6	11 5	14 4	17 3	20 2	23 1	26 0	28 8	31 7	34 6	37 5	40 4	43 3
27	3 0	6 0	9 0	12 0	15 0	18 0	21 0	24 0	27 0	30 0	33 0	36 0	39 0	42 0	45 0
28	3 1	6 2	9 3	12 4	15 5	18 6	21 7	24 8	28 0	31 1	34 2	37 3	40 4	43 5	46 6
29	3 2	6 4	9 6	12 8	16 1	19 3	22 5	25 7	29 0	32 2	35 4	38 6	41 8	45 1	48 3
30	3 3	6 6	10 0	13 3	16 6	20 0	23 3	26 6	30 0	33 3	36 6	40 0	43 3	46 6	50 0

The Content of the Work in square Yards and odd Feet.

The

The Uſe of the Table.

In a Cieling 26 Foot long and 15 Foot broad, how many Yards are contained?

Seek 15 in the head of the Table, which you ſhall find over the laſt Column,) and under it, juſt againſt 26, you ſhall find 43 Yards and 3 Foot, and ſo many Yards are contained in that Cieling.

II. *A Joyner hath Wainſcoted a Room 7 Foot high, and 29 Foot about, how many Yards are therein contained?*

Seek 7 in the head of the Table, and 29 in the firſt Column next your left Hand, and juſt againſt 29, and under 7 in the head of the Table, you ſhall find 22 Yards and 5 Foot, and ſo many Yards doth the Room contain.

If the Work, whoſe content you deſire to know, be too large for the Lengths and Breadths in this Table, you may take the half or quarter thereof, and ſo double or quadruple the Number found in the Table accordingly.

CHAP. III.

Of Meaſure by the Square.

ALL manner of *Tiling*, *Flooring*, and *Roofing* is uſually meaſur'd by the *Square of ten Foot*; ſo that 10 times 10, being 100, is counted as a *Square Tiling*; ſo that a *Square* of *Roofing*, or *Flooring* contains juſt 100 *ſquare Feet*. In this kind of Meaſure you ſee the Rod itſelf is divided into 10 Foot, and therefore the Proportion will be,

As 1, is to the length in Feet,
So is the breadth in Feet to the Content in Feet,
every 100 being a Square.

I. *The Tiling on the Roof of the Houſe (both ſides being taken) the breadth contains* 26 *Foot* 50 *parts, and the length of the Houſe* 32 *Foot*, 25 *parts long, how many Square of Tiling is there in this Roof?*

As 1 is to 26, 50 the breadth,
So is 32, 25 the length, to 854, 62, the Content.

By the Line of Numbers.

Extend the Compaſſes from 1, to 26, 50. The ſame Extent will reach from 32, 25 to 854, 62; which is 854 Foot, and 62 hundred parts of a Foot, which we reject as ſuperfluous in this Caſe: So that the 854 foot is 8 Square, and the 54 foot is half a Square, and 4 foot over. So that in this Roof is contained 8 Square, 2 Quarters, and 8 Foot.

II. *A* Barn, *whoſe length is* 123 *Foot, and the length of the Raſters (both ſides being taken)* 62 *Foot, how many Square of Roofing is there in this* Barn?

As 1, is to 62 foot (the breadth)
So is 123 Foot (the length)
To 7626, the Content in feet.

By the Line of Numbers.

Extend the Compaſſes from 1, to 62. The ſame extent will reach the ſame way from, 123, to 7626 foot, which is the Content, that is 76 Square, and 26 foot, which is 1 foot above a quarter of a Square. So that the Roof contains 76 Square, 1 Quarter and 1 foot.

But becauſe it is ſomething troubleſome in very great Numbers, to give the Eſtimate upon the Line to ſo many Places (as heretofour) it will be better to count the length and breadth of the Roof by Rods and parts of a Rod: So in this Example, the length of the Roof will be 12 Rod and three parts, and the breadth 6 Rod and 2 parts: Then,

As 1, is to 21 Rod 3 parts,
So is 6 Rod 2 parts
To 76 Sq. 1 Quarter, and 1 foot. For,

Extend the Compaſſes from 1, to 12 Rod 3 parts, the ſame will reach from 6 Rod 2 parts, to 76 Square and ſomewhat above a Quarter; that is, 27 Rod and 9 foot.

III. *A*

III. *A* Floor *being* 279 *Foot (that is,* 27 *Rod and* 9 *Foot) long, and* 132 *Foot (or* 13 *Rod* 2 *Foot) broad, how many Square is contained in that* Floor?

As 1, is to 27, 9 parts,
So is 13, 2 parts, to
368 Rod, and 28 parts.

Extend the Compaſſes from 1 to 27 Rod 9 parts. The ſame Extent will reach the ſame way from 13 Rod 2 parts, to 368 Rod, and ſomething above a Quarter, for it will reach to 368 Rod and 28 parts.

¶ And thus have you Examples in *Tiling*, *Roofing* and *Flooring*; and as in the other two ſorts of Meaſures before, ſo in this alſo, I will give you a Table ready computed, ſerving for any Work by the *Square*, from 10 foot to 20 foot brood, and and from 10 foot to 40 foot long.

A Table

A Table shewing what number of Squares are contained in any piece of Work, from 10 *Foot to* 20 *Foot broad, and from* 10 *to* 40 *Foot long.*

The Length of the Work in Feet. | The Breadth of the Work in Feet. | The Content of the Work in Squares.

Fe	10 Sq.F.	11 Sq.F.	12 Sq.F.	13 Sq.F.	14 Sq.F.	15 Sq.F.	16 Sq.F.	17 Sq.F.	18 Sq.F.	19 Sq.F.	20 Sq.F.
10	1 0	1 10	1 20	1 30	1 40	1 50	1 60	1 70	1 80	1 90	2 0
11	1 10	1 21	1 32	1 43	1 54	1 65	1 76	1 87	1 98	2 9	2 20
12	1 20	1 32	1 44	1 56	1 68	1 80	1 92	2 4	2 16	2 28	2 40
13	1 30	1 43	1 56	1 69	1 82	1 95	2 8	2 21	2 34	2 47	2 60
14	1 40	1 54	1 68	1 82	1 96	2 10	2 24	2 38	2 52	2 66	2 80
15	1 50	1 65	1 80	1 95	2 10	2 25	2 40	2 55	2 70	2 85	3 0
16	1 60	1 76	1 92	2 8	2 24	2 40	2 56	2 72	2 88	3 4	3 20
17	1 70	1 87	2 4	2 21	2 38	2 55	2 72	2 89	3 6	3 23	3 40
18	1 80	1 98	2 16	2 34	2 52	2 70	2 88	3 06	3 24	3 42	3 60
19	1 90	2 9	2 28	2 47	2 66	2 85	3 4	3 23	3 42	3 61	3 80
20	2 0	2 20	2 40	2 60	2 80	3 0	3 20	3 40	3 60	3 80	4 0
21	2 10	2 31	2 52	2 73	2 94	3 15	3 36	3 57	3 78	3 99	4 20
22	2 20	2 42	2 64	2 86	3 8	3 30	3 52	3 74	3 96	4 18	4 40
23	2 30	2 53	2 76	2 99	3 22	3 45	3 68	3 91	4 14	4 37	4 60
24	2 40	2 64	2 88	3 12	3 36	3 60	3 84	4 8	4 32	4 56	4 80
25	2 50	2 75	3 0	3 25	3 50	3 75	4 0	4 25	4 50	4 75	5 0
26	2 60	2 86	3 12	3 38	3 64	3 90	4 16	4 42	4 68	4 94	5 20
27	2 70	2 97	3 24	3 51	3 78	4 5	4 32	4 59	4 86	5 13	5 40
28	2 80	3 8	3 36	3 64	3 92	4 20	4 48	4 76	5 4	5 32	5 60
29	2 90	3 19	3 48	3 77	4 06	4 35	4 64	4 93	5 22	5 51	5 80
30	3 0	3 30	3 60	3 90	4 20	4 50	4 80	5 10	5 40	5 70	6 0
31	3 10	3 41	3 72	4 03	4 34	4 65	4 96	5 27	5 58	5 89	6 20
32	3 20	3 52	3 84	4 16	4 48	4 80	5 12	5 44	5 76	6 8	6 40
33	3 30	3 63	3 96	4 29	4 62	4 95	5 28	5 61	5 94	6 27	6 60
34	3 40	3 74	4 8	4 42	4 76	5 10	5 44	5 78	6 12	6 46	6 80
35	3 50	3 85	4 20	4 55	4 90	5 25	5 60	5 95	6 30	6 65	7 0
36	3 60	3 96	4 32	4 68	5 4	5 40	5 76	6 12	6 48	6 84	7 20
37	3 70	4 4	4 44	4 81	5 18	5 55	5 92	6 29	6 66	7 3	7 40
38	3 80	4 18	4 56	4 94	5 30	5 70	6 8	6 46	6 84	7 22	7 60
39	3 90	4 29	4 68	5 7	5 46	5 85	6 24	6 63	7 2	7 41	7 80
40	4 0	4 40	4 80	5 20	5 60	6 0	6 40	6 80	7 20	7 60	8 0

The

The Uſe of the Table.

I. *If any piece of Work be* 13 *Foot broad, and* 32 *Foot long, how many Squares are there contained therein?*

Look 13 in the top of the Table, and right againſt 32, in the firſt Column towards the left Hand, you ſhall find 4 *Square* and 16 *Foot*, and ſo much is contained therein.

II. *If a piece of Work be* 19 *Foot one way, and* 37 *Foot the other way, how many Squares are there contained therein?*

Look 19 at the top of the Table, and underneath it juſt againſt 37, in the ſide, you ſhall find 7 Square and 3 Foot, and ſo much is contained therein.

CHAP. IV.

Of Meaſures by the Rod.

HAving dealt with the *Carpenter*, *Joyner*, *Maſon*, *Glaſier*. *Painter*, *Plaiſterer*, &c. we now come to have to do with the *Bricklayer*, whoſe Meaſure differs from all the reſt, for they do meaſure by the *Rod Square*, each Rod containing 16 Foot and an half in length; ſo that one of theſe Rods in length, and one in breadth, do make a *Rod Square*, which contains 272 and a quarter ſquare Feet. Now if you have a Rod of 16 Foot and a half, divided into 10 or 100 Parts, then your length and breadth being given in Rods, and parts of a Rod, you may by the *Line of Numbers* work as if they were Feet, as before: But if you meaſure your length and breadth by Feet and parts of a Foot, then your Proportion will be,

As 272 and a quarter is to 1,
So is the ſuperficial meaſure of the Wall in Feet,
To the Content of the Wall in Rods.

Example.

Suppoſe a Wall upon the flat to contain 2178 ſuperficial Feet: Then, the extent of the Compaſſes from 272¼, downwards to 1, will reach from 2178, downwards to 8. And ſo many Rods are contained in that Wall.

I. *If a* Brick-Wall *be* 90 *Foot long, and* 12 *Foot high, how many Rod of Brick-work is contained therein?*

The Proportion is,

1. As 1, is to 12 Foot the *Height*,
So is 90 Foot the *Length*, to 1080 foot, the Content in Feet.
Then,
2. As 272 $\frac{1}{4}$ is to 1,
So is 1089 foot, the Content in Feet,
To almoſt 4, the number of Rods contained in that Wall.

1. Extend the Compaſſes from 1, to 12 (the height of the Wall.) The ſame Extent will reach the ſame way, from 90 (the length of the Wall) to 1080.

Then,

2, Extend the Compaſſes from 272 $\frac{1}{4}$, downwards to 1. The ſame Extent will reach from 1080 downwards, to almoſt 4 Rod, and ſo much is contained in that Wall.

II. *If a Wall or ſide of a Houſe be* 24 *Foot long, and* 37 *Foot high, how many Rod of Work is contained in it?*

1. As 1 is to 24 foot the Length,
So is 37 foot the Height, to 888 foot, the Content in feet.
2. As 272 $\frac{1}{4}$, is to 1,
So is 888, to 3 Rod and a Quarter.

For,

1. Extend the Compaſſes from 1, to 24. The ſame Extent will reach from 37, to 888, the Content in feet.

2. Extend the Compaſſes from 272 $\frac{1}{4}$, downwards to 1. The ſame Extent will reach from 884, to 3, 25 parts, that is 3 Rod, and a Quarter, and ſo many Rod of Brick-work is contained in that Wall: And ſo let theſe two ſerve for Examples for the meaſuring of Brick-work.

But beſides this way of meaſuring of their Brickwork by the Rod, there is another thing to be conſidered, *viz.* the Thickneſs of the Wall, for all Walls of the ſame length and height do not contain the ſame quantity of Rods, for the thicker the Wall is the more Rods will be contained therein, their Standard for thickneſs being one Brick and a half; ſo that if a Wall be thicker than one Brick and half, a Square Rod upon the Superficies of the Wall will contain above a Rod, and a Rod upon the Superficies of a Wall that is leſs than a Brick and a half thick, will contain

tain leſs than a Rod when it is reduced to the thickneſs of one Brick and half, as all Walls (of what thickneſs ſoever) muſt be; ſo that every Rod upon the Superficies of a Wall that is 3 Bricks thick, will contain 2 Rod, becauſe 3 Bricks is twice as thick as a Brick and half. And now the manner how to reduce any Wall of what thickneſs ſoever I ſhall now come to ſhew, and this is the proportion.

As 3, Is to the number of half Bricks that any Wall is in thickneſs,
So is the number of Feet contained on the ſuperficies of that Wall,
To the number of Rods, contained in the Wall; it being reduced to one Brick and half thick.

III. *Suppoſe a Wall of* 4 *Brinks thick, ſhould contain upon the Superficies thereof,* 762 *Foot, and you would know how many it would contain, if it were reduced to a Brick and half; ſay,*

As 3 is to 8, the number of Half-Bricks
So is 762, the ſuperficial Feet on the out-ſide of the Wall,
To 2032, the number of Feet; it being reduced
to the thickneſs of a Brick and half.

By the Line of Numbers.

Extend the Compaſſes from 3 to 8. The ſame Extent will reach from 762, to 2032, the Quantity of Feet contain'd in the Wall when it is reduced to the Thickneſs of one Brick and half.

IV. *If a Wall of* 8 *Bricks thick ſhould contain upon the Superficies thereof* 75 *Foot, how many Foot would it contain when reduced to one Brick and half thick? Say,*

As 3, is to 16, the half Bricks in thickneſs,
So is 75, the Content on the Superficies of the Wall,
To 400 foot: And ſo many foot will it contain
when reduced to Brick and half.

¶ And thus have you the manner of meaſuring of Brick-work, and alſo the way of reducing it from any thickneſs to the ſtandard thickneſs of one Brick and half, and now, as to the reſt, I will give you a Table by which you may know how many feet and inches in length will make a Rod of Brick-work at any height, from 1 foot high to 30 foot high.

The

The Uſe of the Table.

A Table ſhewing how much in length will make a Rod ſquare of any Brick-wall, from a Foot high to 30 Foot high.

The height of the Wall in Feet.	The Length of a Square Rod in Feet and Inches. Feet	Inch.
2	272	3
1	126	1
3	90	9
4	68	0
5	54	5
6	45	4
7	38	1
8	34	0
9	30	3
10	27	2
11	24	4
12	22	8
13	20	11
14	19	5
15	18	2
16	17	0
17	16	0
18	15	2
19	14	4
20	13	8
21	13	0
22	12	4
23	11	10
24	11	5
25	10	11
26	10	6
27	10	1
28	9	9
29	9	5
30	9	1

1. *If a Brick-wall be 7 Foot high, how much thereof in Length muſt go to make a Rod Square?*

Look in the firſt Column of the Table for 7 Foot, which is the height of the Wall, and right againſt 7 Foot you ſhall find 38 Foot and 1 Inch, and ſo much in Length will make a Rod.

Again, *If a Wall be 26 Foot high, how much in length will make a ſquare Rod?*

Seek 26 in the firſt Column, and right againſt it in the ſecond Column you ſhall find 10 Foot 6 Inches, and ſo much in length will make a ſquare Rod.

And here Note, that this Table ſuppoſes the Wall to be Brick and half thick; if it be thicker or thinner it muſt be reduced as is before taught.

CHAP.

CHAP. V.

Of Solid Meaſure, and particularly of the Menſuration of Stone, Timber, *&c.*

Timber and *Stone* are moſt commonly meaſured by the Foot Solid, that is to ſay, 12 Inches in Length, and 12 Inches in Depth, and 12 Inches in Thickneſs, make a Foot Solid; ſo that a Foot of Solid Stone or Timber, contains 1728 ſolid inches; for 12 inches in length, and 12 inches in breadth, being multiplied together, produce 144 ſquare inches, which is a foot of Board, and 12 times 144 produce 1728, which is a ſolid foot of Timber or Stone.

Now for the menſuration of theſe Solids, there is no Inſtrument comparable to the *Line of Numbers*, both for ſpeed and exactneſs: So that meaſuring the length, breadth and depth of any piece of Stone and Timber by a Foot Rule divided into 100 Parts, the Content or Quantity may be obtained by the Precepts following; of which I ſhall treat

I. *Of ſquared Timber or Stone.*

By ſquared Timber or Stone, I mean ſuch whoſe Sides are ſtrait and parallel. As,

I. *If a* Stone *or piece of* Timber, *be* 1 *Foot* 16 *Parts broad, and* 2 *Foot* 25 *parts deep, and* 16 *Foot* 50 *parts long, how many ſolid Foot of Timber is there in that Piece?*

The Proportion is,

1. As 1, is to 1, 16 Parts the breadth,
So is 2, 25 Parts the depth, to 2 Foot 61 Parts, the ſuperficial Content of the end of the Piece. Then

2. As 1, is to 2, 61 Parts, the Content at the end of the Piece,
So is 16, 50 Parts, the length of the Piece, to 43, 06 Parts,
The Content of the Piece in ſolid Feet.

By the Line of Numbers.

1. Extend the Compaſſes from 1, to 1, 16 the breadth: The ſame Extent will reach from 2, 25 the depth, to 2 Foot 61 Parts, the Quantity of the Piece at the end.

2. Extend the Compaſſes from 1 to 2, 61, the ſame Extent will reach from 16, 50 the length of the Piece, to 43, 06 the Content of the Piece, which is 43 foot, and 06 hundred parts of a foot, which parts are not to be regarded.

II. *If a piece of Timber or Stone, be* 0, 75 *Parts broad, and* 1, 55 *parts deep, and* 20 *Foot long, how much is therein contained?*

1. As 1, is to 0, 75 Parts,
So is 1, 55 parts, to 1, 16 parts the content at the end.
2. As 1, is to 1, 16 parts, the Content at the end,
So is 20 foot the length, to 23, 25 Parts, the ſolid Content.

By the Line of Numbers.

Extend the Compaſſes from 1, to 0, 75 downwards, (becauſe 0, 75 parts is leſs than one foot). The ſame Extent will reach from 1, 55 (downwards alſo) to 1, 16, which is the Content of the end of the Piece. Then

2. Extend the Compaſſes from 1, to 1, 16. The ſame Extent will reach from 20, the length, to 23 foot, 25 parts, the ſolid Content of the Piece, which is 23 foot and one quarter of a foot.

III. *Let a Piece be* 0, 25 *parts broad, and* 0, 62 *parts deep, and* 32 *Foot long, how many Foot ſolid is contained therein?*

1. As 1, is to 0, 25 parts,
So is 0, 62 parts, to 155 parts.
2. As 1 is to 155 parts,
So is 32 the length, to 4, 96 parts the ſolid content.

By the Line of Numbers.

1. Extend the Compaſſes (downwards) from 1, to 0, 25 parts. The ſame Extent will reach (downwards alſo) from 0, 62 parts, to 155 parts. Then,

2. Extend the Compaſſes from 1, to 0, 155 parts, the ſame will reach from 32 foot, the length, to 4 foot 96 parts, which is almoſt 5 foot, and may be ſo called. And thus much for ſquared Stone or Timber.

¶ But before I proceed I muſt needs detect one grand and too common an Error; for moſt Artificers, when they meet with ſquared Timber whoſe breadth and depth are unequal, they uſu-

uſually add the breadth and depth together, and take the Half for a *mean Square*, and ſo proceed. This indeed, tho' it be always an Error, yet it is not ſo great when the difference of the breadth and depth is not much; but if the Difference be great, the Error is very obnoxious either to Buyer or Seller. I will inſtance in one Example?

IV. *Let a Piece of Timber be* 2 *Foot* 24 *parts broad, and* 1 *Foot* 30 *parts deep, and* 26 *Foot long, how many Foot are contained therein.*

Firſt for the true Way.

1. As 1, is to 2, 24 parts the breadth,
So is 1, 30 parts the depth, to 2, 92 parts, the Content at the End.
2. As 1, is to 2, 92,
So is 26 the length, to 56, 07, the Content, which is 56 Foot, and about an Inch.

Now for the cuſtomary falſe Way.

The breadth of the Piece is	2, 24
The depth thereof is	1, 30
Their Sum is	3, 54
The half Sum is	1, 77

And this 1, 77 Parts they take for a true Square, which is egregiouſly falſe; For, now come to the *Line of Numbers*, and ſay,

1. As 1, is to 1, 77 parts, ſo is 1, 77 parts to 3, 13 parts.
2. As 1 is to 3, 13 parts, ſo is 26 the Length, to 81, 45 parts, that is, to 81 foot and almoſt half a foot; whereas, by the true Way, it contains but 56 foot, and 07 parts. The difference in this Piece being 25 foot, and above one third part of a foot, which is above half a Load of Timber; and Timber being at 50 *s.* or 3 *l. per* Load, here is 25 or 30 *s.* loſt by the Buyer, and gained by the Seller; a conſiderable Fallacy, to buy *One Load*, and pay for above *a Load and a half*. But if People will be deceiv'd, let them be deceiv'd. And thus I ſhall conclude with ſquared Timber, equal at both Ends: Only I will firſt give you a Table ſhewing how much in length will make a ſolid Foot of *Timber*, the ſide of the Square at the end thereof being given in Feet and Inches, from 1 Inch ſquare to 3 Foot, or 36 Inches the Square.

A Table

A Table ſhewing how much in length will make a Solid Foot of ſquared Timber, the ſide of the Square at the end thereof being known.

The ſide of the Square. F.	Inch	The Length of a Foot Solid. F	In.	p.	The ſide of the Square F.	Inch	The Length of a Foot Solid. F.	In.	p.	The ſide of the Square. F.	Inch	The Length of a Foot Solid. F.	In.	p.
O	0				I	0	1	0	0	II	0	0	3	0
	1					1	0	18	2		1	0	2	8
	2					2	0	8	8		2	0	2	6
	3					3	0	7	6		3	0	2	3
	4					4	0	6	7		4	0	2	2
	5					5	0	5	9		5	0	2	1
	6	4	0	0		6	0	5	3		6	0	1	9
	7	2	11	2		7	0	4	8		7	0	1	8
	8	2	3	0		8	0	4	3		8	0	1	7
	9	1	9	3		9	0	3	9		9	0	1	6
	10	1	3	3		10	0	3	5		10	0	1	5
	11	1	2	3		11	0	3	3		11	0	1	4
I	0	1	0	0	II	0	0	3	0	III	0	0	1	3

The Uſe of the TABLE.

If your Timber or Stone have all the ſides equal at the end, then find the length of one of them in this Table, and againſt that Number you ſhall have the length of a Foot. Thus, if the ſide of the Square be 1 foot 10 inches, look this Number in the Table, and right againſt it you ſhall find 3 inches and 5 tenth parts of an inch, which is half an inch; which ſhews that 3 inches and an half in length, will make a Foot Solid of that piece of Timber.

But if the ſides of the Square at the end of the Piece be unequal, that is to ſay one longer than another, you may find the true Square by help of your Line of Numbers thus. Divide the Diſtance upon the Line between the two unequal Sides, into two equal Parts, and the Compaſſes ſhall reſt upon the true Square, and with that Number yon muſt enter the Table.

CHAP.

CHAP. VI.

Of un-equal ſided (but ſquared) Timber *or* Stone.

THoſe pieces of Timber or Stone, whoſe ſides are neither equal nor parallel (only the two ends are ſuppos'd parallel,) I call *un-equal ſided ſquared Stone* or *Timber*, which is bigger at one end than at the other, and in this form do moſt *Timber-Trees* grow, and being fell'd, are ſo hewn and brought to *Square.*

The uſual way to meaſure ſuch Timber is to take a Square about the middle of the Piece, and not at either end, and this middle they take for a *mean Square*, and work with it as if the Piece would bear the *Square* throughout; but in this there is a great Error, for the Content of the Piece thus found, will be ever leſs than the Truth, as the former Error made the Piece more.

But to paſs by this (too cuſtomary way) I will here deliver the Geometrical true way, which is demonſtrable. And that is this.

I. *Find the Content of the Piece at both Ends, and multiply the one Area or Content by the other.* 2. *Out of this Product of the two Area's extract the Square Root.* 3. *Add this Root, and the two Areas of the two Baſes all three into one Sum.* 4. *Multiply this Sum by one third part of the length of the Piece, and that Product ſhall give you the Content thereof in ſolid Feet.*

Examples.

1. *There is a piece of Timber, whoſe breadth at the greater end is* 1 *Foot and* 75 *parts, and its depth* 1, 32. *The breadth at the little end is* 1, 2 *Parts, and the depth* 0, 91 *Parts. And the length thereof is* 12 *Foot,* 60 *parts how many Solid Feet are contained in this Piece?*

By the Line of Numbers.

1. As 1 is to 1, 32 parts, the *depth*,
So is 1, 75 parts, the *breadth*,
To 2, 31 parts, the *Content*, or *Area* } Of the greater *end* of the Piece.

2. As 1, is to 0, 91 parts, the *depth*,
So is 1, 20 parts, the *breadth*,
To 1, 09 parts, the *Area* or *Content* } Of the leſſer *end* of the Piece.

3. As 1, is to 2, 31 parts, the *Area of the greater end*,
So is 1, 09 parts, the *Area of the leſſer end*,
To 9, 522 the *Product* of the two *Areas*.

4. To find the ſquare Root of this Number, you muſt divide the ſpace between 2, 522 the Product, and 1, upon your Line of Numbers, and the Compaſs's point will reſt upon 1, 588.

4. Add this Root 1, 588, and

The Product of the $\left\{\begin{matrix}1,092\\2,310\end{matrix}\right\}$ two Ends together;

The Sum is, 4, 990. Then ſay,

5. As 1, is to 4, 2 parts, the *third part of the length of the Piece*,
So is 4, 99 parts, the *Sum* before found,
To 20, 95 parts, the *ſolid Content of the Piece*.

The Operation.

1. Extend the Compaſſes from 1, to 1, 32. The ſame will reach from 1, 75 to 2, 31, the *Area of the greater End*.

2. Extend the Compaſſes from 1, downwards to 0, 91, the ſame will reach downwards from 1, 20 to 1, 09, *the Area of the leſſer End*.

3. Extend the Compaſſes from 1, to 2, 31, the *greater Area*. The ſame Extent will reach from 1, 09, *the leſſer Area*, to 2, 522.

4. Divide the Diſtance between 1, and 2, 522 upon the Line, into two equal parts, and the Compaſs's point will reſt upon 1, 588, *the ſquare Root*; which added to

The two Products $\left\{\begin{matrix}1,092\\2,310\end{matrix}\right\}$

The Sum will be 4, 990

5. Extend the Compaſſes from 1, to 4, 20 parts, *the third part of the length of the Piece*. The ſame Extent ſhall reach from 4, 99 *the Sum*, to 20, 95 the *Content of the Piece*. So that this Piece of Timber contains 20 Foot 3 quarters, and 20 hundred parts of a Foot.

III. *If*

III. *If a piece of tapering Timber being exactly ſquare at each end, the ſide of the greater End being* 1 *Foot* 50 *parts, and the ſide of the leſſer End* 0, 5 *parts, and the length* 30 *Foot, how many ſolid Foot in that piece of Timber?*

In this Example I will only ſet down the Proportion, and leave the Practice to the Reader.

1. As 1, is to 0, 5 parts,
So is 0, 5 parts, to 0, 25 parts, *the Area of the leſſer End.*
2. As 1, is to 1, 5 parts,
So is 1, 5 parts to 2, 25, the *Area of the greater End.*
3. As 1, is to 0, 25 parts,
So is 2, 25 to 5625 parts.

.75
2. 25
. 25
3. 25

The half Diſtance between 5625, and 1, is 75, the ſquare Root of 5625, which added to the *Area* of the two *Ends*, *viz.* To 2, 25 and 0, 25 make 3, 25, as in the Margin. Then

4. As 1, is to 3, 25, the Sum before found,
So is 10, *one third part of the Length*,
To 32, 50; the *ſolid Content of the Piece*;
That is, 32 Foot and an half.

And ſo let theſe Examples ſuffice in the meaſuring *tapering Timber.*

CHAP. VII.

Of the menſuration of round Timber.

AS there are grand cuſtomary Errors continually committed in the menſuration of unequal-ſided and in tapering Timber, ſo there is one alſo in the meaſuring of round Timber, which tranſcendeth them all; and that is this: In Timber-Trees they uſually girt the Tree about the middle of the Trunk thereof, with a Line, and take one fourth Part of that Girt for the ſide of a Square, and with this they find the Content of the Tree, as if it were a Square, whoſe ſide is equal to a fourth part of that Girt; but this is egregiouſly falſe, for it always gives the Content of the Tree to be near,

near, and moſt commonly above one fifth part leſs than the true Content. But for the maintaining of this ill Cuſtom they plead,

The *Overplus Meaſure* may well be allow'd, becauſe the *Chips* cut off, are of little Value, and will not near countervail the Labour of bringing the Timber to a Square, to which Form it muſt be brought before it be fit for Uſe.

To this I anſwer, that altho' the Chips in ſmall Timber-ſticks be but of ſmall Value, yet in great Trees there be large *Slabs*, and ſo the Labour of hewing is not loſt and only the Chips allowed; but notwithſtanding I do not ſay, that Timber ſtanding ought to be meaſured falſely, but truly, and if any allowance be to be made, let it be in the *Price*, and not in the *Quantity*; and as the *Quantity* will be one fifth part more than in reality it is, ſo a fifth part might rather be abated in the Price. Beſides this, if Timber be thus meaſured and bought when it is round, I ſay, that a Tree, when it is hewed, and brought to ſuch a Square as Timber is uſually brought to, and meaſured as it then is hewed, that Timber-ſtick ſhall then hold out more Meaſure than when it was bought round.

Divers other Errors in the menſuration of ſolid Bodies have crept in for lack of Art, and the Ignorant being poſſeſſed thereof do plead Preſcription and Cuſtom, whereas Cuſtom cannot eſtabliſh a Law upon a bad Foundation and falſe Ground, neither can Error prevail againſt Truth, nor Ignorance convince Reaſon ſupported by Art upon Demonſtration: But leaving theſe and them (who are wedded) to their ill Cuſtoms, I will proceed to ſhew the true and exact way of meaſuring of round Timber.

As in ſquared Timber the Ends thereof were either *equal* or *unequal*, that is, greater at one End than at the other, and ſo were parts of Pyramids: So in round Timber either the Circles at both Ends of the Piece are either *equal*, and ſo are *Cylinders*, or elſe are *unequal*, and ſo are *defected Cones*. And how to meaſure either of of them I ſhall now ſhew, beginning with

CHAP.

CHAP. VIII.

Of Round Timber whoſe Ends are Equal.

BEfore Round Timber can be meaſured, the *Area*, or *Content* of the Circle or Circles at the Ends thereof muſt firſt be found; Wherefore, before I come to meaſure Round Timber I muſt add theſe neceſſary *Problems* concerning the *Circle*.

I. *The Circumference of a Circle being given, to find the length of the Diameter.*

Let the *Circumference* be 3 foot 25 parts, and let the *Diameter* be required.

As 22, is to 7,
So is the *Circumference* 3, 25
To 1, 03 parts, the length of the *Diaueter*.

By the Line of Numbers.

Extend the Compaſſes from 22 downwards, to 7. The ſame Extent will reach from 3, 25 parts downwards, to 1, 03 the length of the *Diameter*.

II. *The Diameter being given, to find the Circumference, let the Diameter be* 2, 50 *parts and the Circumference required.*

As 7, is to 22,
So is 2, 50 the *Diameter*, to 7, 85 parts the *Circumference*.

By the Line of Numbers.

Extend the Compaſſes from 7, to 22, the ſame will reach from 2, 50 parts, to 7, 85 parts for the *Circumference*.

III. *The Diameter of a Circle being given, to find the Area or Content thereof.*

Let the Diameter of a Circle be 2, 5 parts, and let it be requir'd to find the Area.

As 28, is to 22,
So is 6, 25 (which is the Square of the Diameter)
To 4, 91, the Area of the Circle.

By the Line of Numbers.

1. Take in your Compaſſes the Diſtance from 1, to the 2, 5 parts, the Diameter given, and turn the Compaſſes about upon that Point, ſo ſhall the other Point fall upon 6, 25 parts, which is the Square of the Diameter 2, 5.

2. Extend the Compaſſes from 28 downwards to 22. The ſame Extent will reach from 6, 25 the Square, to 4, 91 parts, the Area or Content of the Circle.

IV. *The Circumference of a Circle being given, to find the Area.*

Let the Circumference of the given Circle be 7, 85 parts, and let the Area be required.

As 88, is to 7,
So is 61, 62 parts (the Square of the Circumference)
To 4, 91 parts, the Area, as before.

By the Line of Numbers.

1. Take the Diſtance from 1 (downwards) to 7, 85, the Circumference given, and upon that Point turn the Compaſſes downwards, ſo will the Compaſs Point reſt upon 61, 62 parts.

2. Extend the Compaſſes from 88, downwards to 7, the ſame will reach from 61, 62 parts the Square of the Circumference) to 4, 91 Parts, the Area or Content of the Circle.

But

But now, before I ſhew how to meaſure tapering Timber, I will, (as in the reſt before) give you a Table by which, having the Girt of any Timber-Tree in Inches, you may know how much in Length thereof will make a Solid Foot.

The Compaſs of the Tree in Inches.	In.	10 p.
12	150	8
13	128	5
14	110	8
15	94	8
16	84	8
17	75	8
18	67	10
19	60	11
20	54	3
21	49	2
22	48	9
23	40	9
24	37	7
25	34	7
26	32	7
27	29	8
28	27	8
29	25	8
30	24	7
31	22	8
32	21	6
33	19	9
34	18	8
35	17	7
36	16	7
37	15	9
38	15	4
39	14	3
40	13	6
41	12	9

The Length of a Solid Foot in Inches and 10ths of Inches.	In.	10 p.
42	12	3
43	11	7
44	11	2
45	10	7
46	10	3
47	9	9
48	9	6
49	9	2
50	8	9
51	8	7
52	8	3
53	8	0
54	7	7
55	7	4
56	7	1
57	6	9
58	6	6
59	6	4
60	6	1
61	5	9
62	5	6
63	5	4
64	5	1
65	5	0
66	4	8
67	4	6
68	4	4
69	4	2
70	4	0
71	3	8

The Length of a Solid Foot in Inches and 10ths of Inches.	In.	10 p.
72	3	6
73	3	4
74	3	2
75	3	0
76	2	9
77	2	7
78	2	5
79	2	3
80	2	2
81	2	0
82	1	8
83	1	7
84	1	5
85	1	3
86	1	2
87	1	0
88	0	9
89	0	7
90	0	6
91	0	4
92	0	3
93	0	1
94	0	0
95	0	0
96	0	0
97	0	0
98	0	0
99	0	0
100	0	0

The Uſe of the Table.

Find the Girt or Compaſs of the Tree in Inches in the Column of Inches, and right againſt it you ſhall find how many Inches and 10th parts of Inches will go to make a Foot Solid.

Example. If a Tree be 57 Inches about, look for 57 Inches in the Column of Inches, and againſt it you ſhall find 6 Inches and 7 10th parts of an Inch, which is almoſt three quarters of an Inch, and ſo much in Length will make a Foot Solid.

CHAP.

CHAP. IX.

Of Round Timber whoſe Ends are unequal.

I. *A round Piece of Timber, whoſe Girt or Circumference is 7 Foot 85 Parts, and 15 Foot Long, how many Solid Foot is therein contained.*

BY the laſt Problem before-going, you found the Area of a Circle, whoſe Circumference was (as this is) 7,85 parts, to be 4, 91, that is 4 Foot 91 parts of a Foot. Now the length of the Tree or Piece being 15 Foot, ſay,

As 1, is to 4, 91 (the Area at the end)
So is 15 the length, to 73, 65 parts the Solid Content.

By the Line of Numbers.

Extend the Compaſſes from 1, to 4, 91, the Area at the End. The ſame will reach from 15 (the length of the Piece) to 73 foot 65 parts, which is half a foot, and 15 hundred parts of a foot.

II. *A piece of round tapering Timber, the Circumference (or Girt) at the greater end is 7, 85 parts, as in the laſt, and the Girt at the leſſer end 5, 5, and the Piece is 18 foot long, how many Solid Feet is contained in this Piece?*

1. By the 4th before going, find the Area at either End, ſo ſhall you find the Area of the greater End to be 4, 91, and of the leſſer, 2, 27. Then ſay,

1. As 1, is to 2, 27 parts, the Area of the leſſer End,
So is 4, 91 parts, the Area of the greater End,
To 11, 14 parts, the Product of the two Areas.

By the Line of Numbers.

1. Extend the Compaſſes from 1, to 2, 27. The ſame Extent will reach from 4, 91, to 11, 14, which is the Product of the Areas of the two Ends.

2. Divide theſpace between 1, and 11, 14 upon the Line, into two equal parts, and the Compaſſes will fall upon 3, 40, which is the Square Root of the Product of the two Areas: Add this Root and the Area of the two Ends, all three into one Sum as is done in the Margin, which Sum will be 10, 58, and then,

2, 27
3, 40
4, 91
10, 58

As 1, is to 6 (which is *one third part* of the *Length*)
So is 10, 58 parts, to 63, 84, the *Solid Content.*

Therefore

Therefore

Extend the Compaſſes from 1. to 6. the ſame Extent ſhall reach from 10. 58 Parts, to 63. 48 Parts the *Solid Content* of the Piece; ſo that this Piece of *Tapering round Timber* doth contain 63 *Foot* and an half, wanting only two hundred Parts, which is not to be mention'd; and let this ſuffice for the Menſuration of Solids.

I might make a farther Progreſs herein, as to ſhew the manner how to meaſure Priſmes, Pyramids, Cones and Fruſtums of either of theſe, whether upright or ſchalene, as alſo of Regular Bodies, with divers other Curioſities in Solid Geometry; but this Book was not intended for Curioſity, but Profit, and therefore I have inſerted only ſuch as are pertinent to my intended Deſign.

CONCLUSION.

IN this *Book* throughout, before I ſhew how to work upon the *Line of Numbers*, I do lay down the *Analogy* or *Proportion* by which the *Problem* is to be wrought; by which (if you have not a Rule with the Line of Numbers upon it, or want Compaſſes) you may work the ſame with the Pen, arithmetically, for the Proportions are no other than Queſtions ſtated in the *Golden Rule*, as thus:

If a Board be 1 Foot 25 Parts broad, and 16 Foot 5 Parts long, how many Square Foot are contained in this Board?

As 1. is to 1. 25, So is 16. 5, to what?

.1.25
825
330
165

The Anſwer will be 20 | 625. Which is 20 Foot, 62 Parts, which is half a Foot, and half a quarter of a Foot.

For if you multiply the ſecond Number by the third, *viz.* 16. 5 by 1. 25, the Product will be 20. 625, which ſhould be divided by the firſt Number; but being it is an Unite, it neither multiplies nor divides, and therefore the Number 20. 625 is the Number that anſwers the Queſtion, and is the Content of the Board, *viz.* 20 Foot and an half, and half a quarter. Again,

Take another Example.

If a Board that is 12 *Inches broad doth require* 12 *Inches in length to make a Foot Square, how much in length will make a Square Foot when the Board is* 1 *Foot and* 3 *Inches broad?*

Set the Numbers thus:

broad long broad
If 12 In. require 12 In. what ſhall 15 In. require?

12

24
12

144

5(9
x44 (9 $\frac{8}{15}$, or 9 $\frac{3}{5}$.
x5

This Queſtion is reſolved by *reciprocal Proportion*, or the *backer Rule of Three*, which is eaſily diſcover'd; for 15 Inches being more than 12, it muſt needs require leſs length than 12 Inches to make a Foot; wherefore multiply the firſt and ſecond Terms together, *viz.* 12 by 12, they produce 144, which divide by 15 the breadth given (the third Number in the Proportion) the Quotient will be 9 and $\frac{8}{15}$, or $\frac{1}{2}$ of an Inch; ſo that 9 Inches and $\frac{1}{2}$ will make a Foot Square.

In like manner, *If a Board or Pane of Glaſs, or the like, be* 18 *Inches broad, then* 8 *in length will make a Foot*, as appears by the Work following.

If 12 require 12, what 18?

12

24
12

144

8
x44 (8 In.
x8

Now you are to take Notice, That all the *Examples* in this *Book*, ſuppoſe the *Foot* or *Yard* to be divided into 10 or 100 Parts, which is called *Decimal Diviſion*; ſo all the *Proportions* are laid down in *Decimal Numbers*, and muſt be wrought by *Decimal Arithmetick*, concerning which there is ample Satisfaction to be had in my *Book* treating both of *Vulgar*, *Decimal*, and *Inſtrumental* ARITHMETICK.

The End of the Seventh Book.

The COMPLEAT SURVEYOR.

The Eighth Book.

The *ARGUMENT.*

FOR *farther Illuſtration of the* Table *of* Sines *and* Tangents *in the* Third Book, *and alſo of the proportional* Lines *upon the* Index *of your* Table *mention'd in the* Second Book, *I have in this* Eighth Book *applied them to the making of* Sun-Dials, *as a thing I conceive both uſeful and neceſſary, as well for a* Surveyor, *as other Perſons, who may have occaſion for the ſame. But I intend not here to make an entire Treatiſe of the whole Art of* DIALLING, *(having lately done that already, both* Arithmetically,

tically, Geometrically, *and* Inſtrumentally, *in a particular Treatiſe lately by me publiſhed) but to ſhew you the Uſe of the forementionꝺ* Tables *and* Lines *in the Calculation of the* Requiſites *and* Hour-Diſtances *for all manner of* Horizontal *and* upright Dials, *whether* direct *or* decli. ning, *and that in any* Latitude *or Part of the* World. *Which* upright *and* Horizontal Dials, *of all others, are the moſt uſeful and neceſſary, they ſerving not only for the making of ſome one ſingle* Dial, *but to adorn and furniſh divers* Regular *or* Polyhedronick *Bodies cut in Wood or Stone, which the Precepts in this following* Book *will be a ſufficient* Tutor *to direct unto; omitting to ſay any thing concerning* Reclining *and* Inclining Dials, *which do* decline, *and that for the Reaſon before given. To this* Book *I have added alſo (for the Satisfaction of ſuch as delight therein) ſeveral other* Ways, Rules *and* Tables, *to find the* Hour *of the* Night *by the* Moon *and* Stars, *as well as by the* Sun *in the* Day-*time: And with theſe, and ſome other things of the like Nature, I do conclude this* Eighth Book.

OF

OF DIALLING.

CHAP. I.

BEFORE I come to ſhew how the Hour-Lines are to be deſcribed upon any Dial-Plain, it will be requiſite to know firſt, how ſuch Plain, upon which you intend to deſcribe or draw a Dial, is ſituate in reſpect of the four Cardinal Points of the *World* (or rather of your particular *Horizon*) that is, whether the Dial-Plain do directly behold either the Eaſt, Weſt, North or South Points, or not; for if they do behold either of the forementioned Points, they are called direct Eaſt, Weſt, North or South Dials; but if they do not behold any of theſe Points directly, they are then ſaid to decline. So a Dial-Plain lying between the {South / North} Points and the Eaſt, is ſaid to be a {South / North} Plain declining Eaſtward, ſo many Degrees as the Plain leaneth from the Eaſt or Weſt. Alſo a Dial-Plain lying between the {South / North} Points and the Weſt, is denominated to be a {South / North} Plain declining Weſtward, ſo many Degrees as the Plain deviates from the Weſt or Eaſt. Now to find the true Situation of any Plain, there are ſeveral ways. The moſt eaſy and common way is by the magnetical Needle, ſuch as is in the Box of your Plain Table. For if you apply the ſide of

your Box to the Dial-Plain, holding it level, the Needle will ſhew you how many Degrees the Plain deviates or declines from the true North, South, Eaſt or Weſt Points. This is ſo plain, that an Example to be given thereof were needleſs: and beſides, the way itſelf is uncertain, in regard the Needle hath ſome Variation, and ſo points not at all times to the true North Point; and therefore is not to be uſed but in caſe of Neceſſity, when you cannot have the Benefit of the Sun's ſhining.

The beſt and moſt abſolute way to attain this Declination therefore is by the Sun; for by finding of the Sun's *Azimuth* at any time, the Declination of any Wall may be attained. And therefore I ſhall firſt ſhew you how to find the Sun's *Azimuth* at any time when the Sun ſhineth, and that two ſeveral ways: *viz.* one Geometrically, by help of your Line of Chords; the other Arithmetically, by help of the Table of Sines. And becauſe the Sun's Declination is requiſite to be known before you can compute the *Azimuth*, I have here added a Table ſhewing the Sun's Declination for every Day in the Year; and following the ſame, another Table ſhewing the Latitude of all the principal Cities and Towns in *England*, *Scotland* and *Ireland*, alphabetically diſpoſed; ſo that when you are required to make a Dial in any of theſe Kingdoms, you need not be to ſeek for the Latitude of your Place whereſoever you be.

CHAP.

A Table

A Table shewing the Sun's Declination for every Day of the Year, serving for the more ready finding of the Sun's Azimuth.

A Table of the Sun's Declination.

Days.	Janu. d.	m.	Febr. d.	m.	Marc. d.	m.	April d.	m	May d.	m.	June d.	m.	July d.	m.	Aug. d.	m.	Sept. d.	m.	Octo. d.	m.	Nov. d.	m.	Dec. d.	m.
1	21	44	13	46	3	24	8	36	18	5	23	12	22	8	15	12	4	24	7	15	17	40	23	9
2	21	33	13	26	3	0	8	58	18	20	23	16	22	0	14	54	4	2	7	38	17	56	23	13
3	21	23	13	5	2	37	9	20	18	35	23	19	21	51	14	36	3	38	8	0	18	12	23	17
4	21	13	12	45	2	13	9	42	18	50	23	22	21	42	14	17	3	15	8	22	18	28	23	20
5	21	2	12	25	1	49	10	3	19	4	23	25	21	32	13	58	2	52	8	45	18	45	23	23
6	20	50	12	4	1	25	10	24	19	18	23	27	21	22	13	39	2	29	9	7	18	58	23	26
7	20	38	11	43	1	1	10	45	19	31	23	29	21	12	13	20	2	5	9	29	19	13	23	28
8	20	26	11	21	0	38	11	0	19	44	23	30	21	2	13	1	1	42	9	51	19	27	23	30
9	20	13	11	0	0 South	14	11	27	19	57	23	31	20	51	12	41	1 North	19	10	13	19	41	23	31
10	20	0	10	38	0	10	11	47	20	10	23	32	20	40	12	21	0	55	10	35	19	55	23	31
11	19	46	10	16	0 North	33	12	7	20	22	23	31	20	28	12	1	0 South	32	10	56	20	8	23	31
12	19	32	9	54	0	57	12	28	20	34	23	31	20	16	11	41	0	8	11	18	20	21	23	31
13	19	18	9	32	1	21	12	48	20	45	23	30	20	4	11	21	0	16	11	39	20	34	23	29
14	19	3	9	10	1	44	13	7	20	56	23	29	19	51	11	0	0	39	12	0	20	46	23	27
15	18	48	8	48	2	8	13	27	21	7	23	28	19	38	10	39	1	3	12	21	20	58	23	25
16	18	33	8	25	2	31	13	46	21	17	23	26	19	25	10	18	1	26	12	41	21	9	23	22
17	18	17	8	3	2	54	14	5	21	27	23	23	19	12	9	57	1	50	13	2	21	20	23	19
18	18	2	7	40	3	18	14	24	21	37	23	20	18	58	9	36	2	13	13	22	21	31	23	16
19	17	45	7	17	3	41	14	42	21	46	23	17	18	43	9	15	2	37	13	42	21	41	23	12
20	17	28	6	54	4	5	15	1	21	55	23	14	18	29	8	53	3	0	14	2	21	50	23	7
21	17	11	6	31	4	28	15	19	22	4	23	10	18	14	8	31	3	23	14	21	22	0	23	2
22	16	54	6	8	4	51	15	37	22	12	23	6	17	59	8	9	3	47	14	41	22	9	23	57
23	16	36	5	45	5	14	15	54	22	20	23	1	17	44	7	47	4	10	15	0	22	17	22	51
24	16	18	5	21	5	37	16	12	22	27	22	55	17	28	7	25	4	33	15	19	22	15	22	44
25	16	0	4	58	6	0	16	29	22	34	22	50	17	12	7	3	4	57	15	37	22	33	22	37
26	15	42	4	34	6	22	16	46	22	41	22	44	16	56	6	41	5	20	15	55	22	40	22	30
27	15	23	4	11	6	45	17	2	22	47	22	37	16	39	6	18	5	43	16	13	22	46	22	22
28	15	4	3	47	7	7	17	18	22	53	22	31	16	22	5	56	6	6	16	31	28	52	22	14
29	14	45			7	30	17	34	22	58	22	23	16	6	5	33	6	29	16	49	22	58	22	5
30	14	26			7	52	17	50	23	3	22	16	15	48	5	10	6	52	17	6	23	4	22	56
31	14	6			8	14			23	8			15	30	4	47			17	23			21	

A Table

A Table of the Names and Latitudes of the Principal Cities, Towns, and Iſlands in and about Great Britain *and* Ireland.

ENGLAND.	D.	M.
Bedford	52	8
Berwick	55	54
Briſtol	51	27
Buckingham	52	0
Cambridge	52	12
Canterbury	51	17
Carliſle	55	0
Chicheſter	50	48
Cheſter	53	16
Colcheſter	51	58
Derby	52	58
Dorcheſter	50	40
Durham	54	50
Exceſter	50	43
Gilford	51	12
Gloceſter	51	53
Hartford	41	49
Hereford	52	7
Huntington	52	19
Ipſwich	52	8
Kendal	54	23
Lancaſter	54	10
Leiceſter	52	40
Lincoln	53	14
London	51	32
Northampton	52	14
Norwich	52	42
Nottingham	53	0
Oxford	51	46
Reading	51	28
Salisbury	51	4
Shrewsbury	52	47
Stafford	52	52
Stamford	52	38
Truro	50	30
Warwick	52	20
Wincheſter	51	3
Worceſter	52	14
York	53	58

WALES.	D.	M.
Angleſey	53	28
Barmouth	52	50
Brecnock	52	1
Cardigan	52	12
Carmarthen	51	26
Carnarvan	53	16
Denbigh	53	13
Flint	53	17
Landaffe	51	35
Monmouth	51	51
Montgomery	51	56
Pembroke	51	46
Radnor	52	19
St. Davids	52	0

ISLANDS.	D.	M.
Arnſey	49	30
Jerſey	49	12
Lundy	51	22
Man	54	24
Portland	50	30
Wight	50	39

SCOTLAND.	D.	M.
Berdeen	57	32
Dumblain	26	21
Dunkel	56	48
Edenburgh	55	56
Glaſcow	55	52
Kinſaile	57	44
Orkney	60	6
St. Andrews	56	39
Skyraſſin	58	36
Sterling	56	12

IRELAND.	D.	M.
Antrim	54	38
Arglas	54	10
Armagh	54	14
Caterlaugh	52	41
Clare	52	34
Cork	51	53
Droghedagh	53	38
Dublin	53	13
Dundalk	53	52
Galloway	53	2
Youghall	51	53
Kenny	52	27
Kildare	53	0
Kings Town	53	0
Knockfergus	54	37
Kingſale	51	41
Limerick	52	30
Queens Town	52	52
Waterford	52	9
Wexford	52	18

CHAP.

CHAP. II.

To find the Sun's Azimuth *Geometrically.*

HAVING the Latitude of your Place, and the Declination of the Sun, and the Sun's Altitude given, you may find the Sun's *Azimuth*. So the Latitude of the Place being 51 deg. 30 min. the Declination of the Sun 17 deg. 56 min. North, and the Sun's Altitude 35 deg. the *Azimuth* may be found Geometrically as followeth.

First, Deſcribe with 60 deg. of your Line of Chords the Semicircle A D C, and upon B, the Centre, erect the Perpendicular B D.

Secondly, Take 51 deg. 30 min. the Latitude of the Place, out of your Line of Chords, ſet it from D to E, and draw the Line E B, repreſenting the Equinoctial Circle.

Thirdly, Out of your Line of Chords take 17 deg. 56 min. the Sun's Declination, and becauſe it is Northward, ſet that Diſtance upwards from E to F, (but if the Declination had been Southward, you muſt have ſet it downwards from E to R) and draw the Line F G parallel to B E, which repreſents the Sun's Parallel for that time.

Fourthly, From your Line of Chords take 35 deg. the Sun's Altitude, and ſet it from A to H, and from C to L, and draw the Line H K L for the Line of the Sun's Altitude.

Fifthly, Take in your Compaſſes the Length of the Line K L, or K H, and with that Diſtance upon the Centre B deſcribe the Semicircle M P N.

Sixthly, Upon the Point O (which is where the Parallel of Declination and the Parallel of the Sun's Declination interſect each other) erect the Perpendicular O P.

Seventhly, Lay a Ruler from B to P, and it will cut the Circle in Q, and draw the Line P Q.

Laſtly, Take the Diſtance from C to Q, and meaſuring it upon your Line of Chords, you ſhall find it to contain 74 deg. and ſo much is the Sun's *Azimuth* or his Diſtance from the South part of the Meridian at the time of Obſervation.

CHAP. III.

To find the Sun's Azimuth *Arithmetically by the Table of Sines.*

LET the Latitude, Declination and Altitude, be as before, *viz.*

	d.	m.		d.	m.
Latitude-----	51	30		38	30
Declination	17	56	Complement	72	04
Altitude ----	35	00		55	00
			Their Sum ------	165	34
			Half Sum ---	82	47
			The Difference between the half Sum and the Complement of the Sun's Declination --- --- --- --- ---	10	43

First, You must add the Complement of the Latitude, the Complement of the Declination, and the Complement of the Sun's Altitude, all three into one Sum, and they make 165 deg. 34 min. the half whereof is 82 deg. 46 min. and the Difference between this half Sum 82 deg. 46 min. and 72 deg. 4 min. the Complement of the Sun's Declination is 10 deg. 43 min.

Being thus prepared, the Proportion to find the Sun's *Azimuth* by the Table of Sines will be as followeth:

* (1.) As the Radius or Sine of 90 deg. --- --- ---	10	000000
is to the Sine Complement of the Altitude 55 d.	9	913364
So is the Sine Complement of the Latitude 38 d. 30 m.	9	794149
to the Sine of 30 deg. 40 min. --- --- ---	19	707513
(2.) As the Sine of 30 deg. 40 min. --- --- ---	9	707513
is to the Sine of the half Sum 82 deg. 47 min. ---	9	996594
So is the Sine of the Difference 10 deg. 43 min. ---	9	267395
	19	263989
to this Sine --- --- --- --- ---	9	556476
To which add the Radius or the Sine of 90 deg.	10	000000
The Sum is ---	19	556476
Half this Sum is ---	9	778238

* By observing these two Analogies you may find the *Azimuth* by the Line of Sines on the Index of your Tables.

Which

Which is the Sine of 37 deg. neareſt, the double whereof is 74 deg. for the *Azimuth* from the South Part of the Meridian. And according to either of theſe ways you may find the Sun's *Azimuth* at any Time of the Day, and in any Part of the World. And now I ſhall ſhew you how by the help hereof.

CHAP. IV.

To find the Declination of any Wall or Plain.

THE Declination of a Plain is an Arch of the Horizon intercepted between the North or South Points of the Horizon, and a Line drawn perpendicular to the Plain upon which the Dial is to be made.

Or, it is that Arch of the Horizon which is comprehended between the Plain itſelf, and the Eaſt or Weſt Points of the Horizon.

To attain to the Quantity of this Declination, two Obſervations (the Sun ſhining) muſt be made, and both of them at the ſame Moment of Time, as near as may be. The one is the Horizontal Diſtance of the Sun from that Line which is perpendicular to the Plain: The ſecond is of the Sun's Altitude, whereby the Sun's *Azimuth* muſt be found, according as is taught in either of the two foregoing Sections.

I. *To find the Horizontal Diſtance.*

This ought to be performed by a Semicircle or Quadrant; but the Degrees upon the Frame of the Table will perform that Work, where better Helps are wanting.

Apply therefore that ſide of your Table which is next the Centre to the Wall on which you are to make your Dial, holding the Table as levell as you can; then hold a Thread and Plummet in your Hand, by the ſide of the Table, till the ſhadow of the Thread do directly paſs through the Centre of the Degrees of the Table; and then look how many Degrees and Parts of a Degree are cut by the ſhadow of a Thread, counting thoſe Degrees from 90, at the middle of the Table, either towards the Right or Left Hand; for the Number of thoſe Degrees is the Horizontal Diſtance ſought for, which ſet down, or keep in Memory.

II. *To*

II. *To find the Sun's Altitude.*

This is beſt performed by a Quadrant alſo; but where that is wanting, the Table will ſupply that Defect in this manner:

Stick a Pin up in the Centre of the Degrees of the Table perpendicularly, and upon the ſame hang a ſmall Silk or Thread, having a Plummet at the end thereof. Then holding up the Table in both your Hands, and turning the left-ſide of your Body to the Sun, move the Table either upwards or downwards (as occaſion ſhall offer) till the ſhadow of the Pin doth caſt itſelf along a Line drawn through the Centre of the Table to the beginning of the Degrees, and ſo that the Thread and Plummet may hang at free liberty; ſo ſhall the Degrees that the Thread cutteth upon the Frame of the Table, counted from 90 deg. be the Degrees of the Sun's Altitude, which alſo keep or ſet down in writing. And here note, That you muſt take this Horizontal Diſtance and Altitude both of them as ſoon one after the other as poſſibly may be.

III. *To find the Plain's Declination.*

The *Horizontal Diſtance* and *Altitude* thus obſerved, will help you to the *Plain's Declination* by the *Rules* following: For,

By having the Sun's Altitude and the Sun's Declination for the Day (by the foregoing Table) you may find the Sun's *Azimuth*, as hath been taught in the former Sections. Then by comparing the Sun's Azimuth and the Horizontal Diſtance together, you may come to the *Plain's Declination*, thus;

When you make your Obſervation of the Sun's Horizontal Diſtance, mark whether the ſhadow of the Thread fall between the *South* Point, and 90 deg. of the Table. For,

1. If the ſhadow fall between them, the Sun's *Azimuth* and the Sun's *Horizontal Diſtance* added together ſhall be equal to the *Plain's Declination:* And in this caſe the Declination is toward the ſame Coaſt upon which the Sun then is; that is to ſay, Eaſtward if the Sun be Eaſt of the Meridian, or Weſtward if the Sun be Weſt of the Meridian.

2. If the ſhadow of the Thread fall not between 90 deg. of the Table and the South Point, then the Difference between the Horizontal Diſtance and the Azimuth is the Plain's Declination. And if the Azimuth be the greater of the two, then the Declination is towards the ſame Coaſt whereon the Sun then is. But if the Horizontal Diſtance be the greater, then the Declination is towards the contrary Coaſt to that whereon the Sun is.

And here you are to note, That the Declination thus found is always accounted from the South, and that all Declinations are counted

counted from either North or South, towards either the East or the West, and must never exceed 90 deg. Therefore,

1. If the Declination do exceed 90 deg. you must substract that Number from 180 deg. and the Remainder is the Plain's Declination from the North.

2. If the degrees of Declination do exceed 180, then the Excess above 180 deg. gives the Plain's Declination from the North, and towards that Coast which is contrary to the Coast whereon the Sun is.

Having now taught you to find the Situation of a Plain in any Part of the World, and at any Time of the Year or Day, (although about Noon-tide be very bad for this Work; therefore I would advise no Person to take the Declination of any Wall or Dial-Plain after Ten of the Clock in the Forenoon, nor till after Two in the Afternoon, for fear of Errour; the Sun's Azimuth at that Time of the Day being swiftest, and the Increase of Altitude but very little) I shall now proceed to shew you how to describe Hour-Lines upon all the most usual sorts of Plains, upon which Dials are most generally made; and those are the Horizontal, the direct East, West, North and South Plains, whether direct or declining; and that both by the Tables of Sines and Tangents in the Third Book, and also by the Lines of Sines and Tangents upon the Index of your Table.

CHAP. V.

How to make an Horizontal Dial in any Latitude.

FOR the making of this Dial there is nothing required but the Latitude of the Place, which we will suppose to be *London*, in 51 deg. 30 min. of North Latitude.

The Arithmetical Calculation for this Dial.

1. *By the Tables of Sines and Tangents.*

The Latitude of the Place being known, 51 deg. 30 min. the Analogy or Proportion for finding of the true Hour-Distances upon the Plain will be this following, *viz.*

As the Radius or Sine of 90 deg. ---- ---- ----	10	00000
is to the Sine of the Latitude of the Place 51 d. 30 m.	9	89354
So is the Tangent of 15 deg. which is one Hour's Distance in the Equinoctial ---- --- --- ---	9	42805
	9	32159
to the Tangent of 11 deg. 50 min. whch is the true Distance of the Hour-Lines of 11 and 1 a Clock from 12 --- --- --- ---- ---- ----	9	32159

And in this manner may all the reſt of the Hour-Diſtances upon the Plain be found from 12 a Clock, by the continual Addition of 15 deg. for each Hour. So,

As the Sine of 90 deg. --- ----	10	00000
is to the Sine of 51 d. 30 m. --	9	89354

So is the Tangent of	15 deg.---	9	42805	The Equinoctial Diſtance of	1 Hours
	30 --------	9	76143		2 from
	45 --------	10	00000		3 the
	60 --------	10	23856		4 Meri-
	75 --------	10	57914		5 dian.

	d.	m.				
to the Tang. of	11	50	9	32122	The true Hour-Diſtance of the Hours of	11 1 of the Clock
	24	20	9	65534		10 2 upon the
	38	03	9	89359		9 3 Plain from
	53	35	10	13211		8 4 the Meri-
	71	06	10	46549		7 5 dian.

And according to this Analogy or Proportion all the Hour Diſtances upon the Plain from 12 a Clock are found, and may be put into ſuch a Table as this following:

Hours from the Meridian.		True Hour-Diſtances upon the Plain.	
12		00 deg.	00 m.
11	1	11	50
10	2	24	20
9	3	38	03
8	4	53	35
7	5	71	06
6		90	00

Now from this Table, by help of a Line of Chords, may the Hour-Lines be transferred to the Plain, as ſhall be ſhewed anon.

But firſt I will ſhew how the former Hour-Diſtances may be formed.

2. *By*

2. *By the Lines of Sines and Tangents upon the Index of your Table.*

The Hour-Diſtances by theſe Lines will be found more readily than by the Tables, and ſufficiently exact. For this being

The ANALOGY.

As the Sine of 90
is to the Sine of the Latitude 51 deg. 30 m.
So is the Tangent of 15 deg. 30 deg. 45 deg. *&c.*
to the Tangent of 11 deg. 50 min. *&c.* as in the former Table.

Wherefore, if you extend the Compaſſes from the Sine of 90 deg. downwards to the Sine of the Latitude 51 deg. 30 min. the ſame Extent will reach from the Tangent of 15 deg. downwards to the Tangent of 11 deg. 50 min. the firſt Hour's Diſtance from 12, as in the Table.

Alſo (the Compaſſes not alter'd) will reach from the Tangent of 30 deg. downwards to the Tangent of 24 deg. 20 min. the ſecond Hour's Diſtance, as in the Table. And ſo from 45 deg. to 38 deg. 3 min. and from 60 deg. to 53 deg. 35 min. and from 75 deg. to 71 deg. 6 min.

And thus with once opening of the Compaſſes you have found all the Hour-Diſtances belonging to this Plain.

And in the ſame manner as you do find the whole Hour's Diſtances, by the ſame way may you find the Diſtances of the Halves and Quarters, by allowing 3 deg. 45 min. for one Quarter of an Hour in the Equinoctial, 7 deg. 30 min. for half an Hour, 11 deg. 15 min. for three Quarters, and 15 deg. for an Hour. So,

Extending the Compaſſes from the Sine of 90 deg. to the Sine of 51 deg. 30 min. (as before) the ſame Extent will reach from the Tangent of 3 deg. 45 min. to the Tangent of 2 deg. 56 min. which is the firſt Quarter of an Hour's Diſtance from 12 a Clock; and from 7 deg. 30 min. to 5 deg. 52 min. the firſt Half-hour's Diſtance from 12 a Clock; and from 11 deg. 15 min. to 8 deg. 51 min. three Quarters of an Hour's Diſtance from 12; and ſo all the reſt, as in the Table following.

CAUTION.

When you come to uſe the Line of Tangents beyond 45 deg. you muſt then account 40 deg. to be 50 deg. and 30 deg. to be 60, *&c.* as they are uſually numbred upon the Lines themſelves.

Or if you find this to be inconvenient, you may, when you come to the Tangent of 60 deg. (as at 8 and 4 of the Clock) you may then uſe Croſs-work, by extending the Compaſſes from the Sine of 90 deg. to the Tangent of 60 deg. The ſame Extent will reach from the Sine of 51 deg. 30 min. to the Tangent of 53 deg. 35 min. as before.

Now having thus attained the true Hour-Diſtances upon the Plain, it reſteth to ſhew you *The*

The Hour-Distances for a South or North Dial.

Hours.	Hour-Distances at the Equinoct. d.	m.	True Hour-Distances upon the Plain. d.	m.
XII	00	00	00	00
a quart.	3	45	2	56
half.	7	30	5	52
3 quart.	11	15	8	51
XI I	15	0	11	50
a quart.	18	45	14	52
half.	22	30	17	57
3 quart.	26	15	21	6
X II	30	0	24	20
a quart.	33	45	27	36
half.	37	30	31	0
3 quart.	41	15	34	28
IX III	45	0	38	3
a quart.	48	45	41	45
half.	52	30	45	34
3 quart.	56	15	49	30
VIII IV	60	0	53	35
a quart.	63	45	57	47
half.	67	30	62	6
3 quart.	71	15	66	33
VII V	75	0	71	6
a quart.	78	45	75	45
half.	82	30	80	25
3 quart.	86	15	85	13
VI	90	0	90	0

The Geometrical Conſtruction of this DIAL.

FIG. I. 1. About the middle of the Plain upon which you deſign to draw your Dial, draw a right Line N S, repreſenting the Meridian, or Hour-Line of XII, and croſs it at right Angles with the Line E W, which ſhall be the Hour-Line of VI both in the Morning and in the Evening, E ſtanding at VI in the Morning, and W at VI at Night. And where theſe two Lines interſect each other, which is at O, let it be the Centre of your Dial.

2. Upon O (as a Centre) with 60 deg. of your Line of Chords deſcribe a Semicircle A 12 B: and becauſe your Latitude is 51 deg. 30 min. take 51 deg. 30 min. from your Line of Chords, and ſet it (on either ſide of the Meridian) from XII to C, and draw the Line O C for the Axis or Stile of your Dial.

3. Laying your Table before you, take 11 deg. 50 min. (which is the firſt Hour's Diſtance upon the Plain) out of your Line of Chords, and ſet that Diſtance upon the Semicircle from 12 to 11, and draw the Lines O 11 and O 1 for the Hour-Lines of XI and I.

4. Take the ſecond Hour's Diſtance, 24 deg. 20 min. out of your Line of Chords, and ſet it upon the Semicircle from 12 to 10, and from 12 to 2, and draw the Lines O 10 and O 2 for the Hour-Lines of XII and II.

5. Take 38 deg. 3 min. (the third Hour's Diſtance) out of your Chord, and ſet it from 12 to 9, and from 12 to 3, drawing the Lines O 9 and O 3 for the Hour-Lines of IX and III.

6. Take 53 deg. 35 min. and ſet it from 12 to 8, and from 12 to 4, and draw the Lines O 8 and O 4 for the Hour-Lines of VIII and IV.

7. Take 71 deg. 6 min. and ſet it from 12 to 7, and from 12 to 5, drawing the Lines O 7 and O 5 for the Hour-Lines of VII and V; and the Line E W is the Hour-Line of VI and VI, as was before expreſs'd. And thus have you 12 Hour-Lines deſcribed upon your Plain, namely from 6 in the Morning to 6 at Night. But,

8. For the Hour-Lines before 6 in the Morning, or after 6 in the Evening, they may be ſupplied by continuing their oppoſite Hour-Lines

Lines beyond the Centre. So ſhall the Hour-Line of VII in the Morning become VII in the Evening, when it is extended beyond the Centre O; and VIII in the Morning become VIII in the Evening: And ſo of IV in the Evening will become IV in the Morning, and of V in the Evening V in the Morning.

Laſtly, For the Stile of your Dial, it may be either an Iron Rod, or a Plate of Iron or Braſs, which muſt be equal to the Angle 12 O C, namely 51 d. 30 m. equal to the Latitude of the Place; which being ſet perpendicularly upon the Meridian, or Hour-Line of XII, and its angular Point in the Centre O, it ſhall repreſent the Axis of the World, and be truly placed for the caſting of its Shadow upon the true Hour at all Times of the Day.

CHAP. VI.

How to make a direct South or North DIAL in any Latitude.

FOR the making of theſe Dials there is nothing required to be given but the Latitude of the Place where they are to ſtand, which we will ſuppoſe to be (as before) *London*, whoſe Latitude is 51 d. 30 m. which known, we proceed to

The Arithmetical Calculation of theſe Dials.

1. *By the Table of Sines and Tangents.*

The Latitude of the Place being known, 51 d. 30 m. take the Complement thereof to 90 d. that is, Subſtract 51 d. 30 m. from 90 d. the Remainder will be 38 d. 30 min. which is the Complement thereof. This being known, for finding of the Hour-Diſtances this is

The ANALOGY, or PROPORTION.

As the Sine of 90 deg. ---- --- -- ---	10	00000
is to the Sine of the Complement of the Latitude, *viz.* 38 d. 30 m. --- ---	9	79417
So is the Tangent of 15 deg. which is one Hour's Diſtance in the Equinoctial ———	9	42805.
to the Tangent of 9 d. 28 m. ----- ------	19	22222

Which 9 d. 28 m. is the true Hour-Diſtance of 11 and 1 of the Clock from the Meridian or Hour-Line of XII. And thus allowing 15 d. for one Hour, 30 d. for two Hours at the Equinoctial, all the Hour-Diſtances upon the Plain may be found, and will be as in the Table hereafter following.

2. *By the Lines of Sines and Tangents.*

The Hour-Diſtances by the Lines will be found more readily, as were thoſe in the former Dial, namely, by once opening of the Compaſſes. For the Proportion being,

As the Sine of 90 d.
is to the Sine Comp. of the Latitude 38 d. 30 m.
So is the Tangent of 15 d. 30 d. 45 d. *&c.*
to the Tangent of 9 d. 28 m. *&c.*

Wherefore extend the Compaſſes from the Sine of 90 d. downwards to the Sine of 38 d. 30 m. the ſame Extent will reach from the Tangent of 15 d. to the Tangent of 9 d. 28 m. and from the Tangent of 30 d to the Tangent of 19 d. 45 m. and from the Tangent of 45 d. to the Tangent of 31 d. 54 m. from the Tangent of 60 d. to the Tangent of 47 d. 9 m. and from the Tangent of 75 d. to the Tangent of 66 d. 43 m.

And ſo from the reſpective Tangent of 3 d. 45 m. for a quarter, 7 d. 30 m. for half, and 11 d. 15 m. for 3 quarters of an hour at the Equinoctial, to the Tangent of 2 d. 20 m. 4 d. 41 m. 7 d. 3 m. *&c.* as in the Table. Which Table being thus collected, you may proceed to the drawing of the Hour-lines.

The Hour-Diſtances for a South or North Dial.

Hours.	Hour-Diſtances at the Equinoct.		True Hour-Diſtances upon the Plain.	
	d.	m.	d.	m.
XII	00	00	00	00
a quart.	3	45	2	20
half.	7	30	4	41
3 quart.	11	15	7	3
XI I	15	0	9	28
a quart.	18	45	11	56
half.	22	30	14	27
3 quart.	26	15	17	4
X II	30	0	19	45
a quart.	33	45	22	35
half.	37	30	25	32
3 quart.	41	15	28	38
IX III	45	0	31	54
a quart.	48	45	35	22
half.	52	30	39	3
3 quart.	56	15	42	58
VIII IV	60	0	47	9
a quart.	63	45	51	36
half.	67	30	56	20
3 quart.	71	15	61	23
VII V	75	0	66	42
a quart.	78	45	72	17
half.	82	30	78	3
3 quart.	86	15	84	0
VI	90	0	90	0

The Geometrical Conſtruction of theſe DIALS.

FIG. II. 1. Upon your Dial Plain (about the middle thereof) draw a down-right line A B, which ſhall repreſent the Meridian, and be the Hour-line of XII; and towards the upper part thereof draw another line C D at right Angles thereunto, croſſing each other in the Point E. The line C D ſhall be the Hour-lines of VI in the Morning and VI in the Evening alſo; and E ſhall be the Centre of the Dial.

2. Upon

2. Upon E with 60 d. of your Line of Chords describe a Semicircle C 12 D, and taking 38 d. 30 m. the Complement of the Latitude, set it from 12 to F on either side of the Line A B, and draw the Line E F for the Stile of your Dial.

3. Lay your Table before you, and from your Line of Chords take 9 d. 28 m. and set them upon the Semicircle from 12 to 11, and from 12 to 1, and draw the Lines E 11 and E 1, for the Hour-lines of XI and I.

4. Take 19 d. 45 m. and set them from 12 to 10, and from 12 to 2, and draw E 10 and E 2 for the Hour-lines of X and II; and the like of all the rest, as you find them in the Table, drawing the Hour-lines E IX and E III, E VIII and E IV, E VII and E V, for the true Hour-lines.

The Stile of this Dial may be either a Rod of Iron, or a Plate of Brass or Copper made to an Angle equal to the Complement of the Latitude, *viz.* 38 d. 30 m. equal to the Angle 12 E F. This Stile must stand upon the Hour-line of XII, and issue from the Centre, and must point downwards towards the South-Pole, as you see in the Figure; and so shall it shew the true Hour of the Day. And thus is your South Dial finish'd. Now

CHAP. VII.

For the North DIAL.

FIG. III.

1. UPON the Dial Plain draw an obscure downright Line G H, representing the Meridian, or 12 of the Clock at Midnight About the middle thereof, as at K, draw a right Line perpendicular thereunto, as the Line VI K VI.

2. With 60 d. of your Chord describe upon the Centre K the Circle L M N O, and taking 38 d. 30 m. out of the Line of Chords, set them from L to P, and draw the Line K P for the Stile of your Dial.

Now because this Dial looketh towards the North part of the Meridian, to which in those middle Latitudes without the Tropicks the Sun never cometh, therefore must the Hours about Midnight be omitted, as 9, 10, 11 and 12 at Night, and 1, 2 and 3 in the Morning: So that this Dial is capable only of the Hours of 4, 5, 6, 7 and 8 in the Morning, and of 4, 5, 6, 7 and 8 in the Evening.

3. Lay the former Table made for the South Dial before you, and there you shall find that the Hour-Distances of VIII and IV of the Clock are distant from the Meridian 47 d. 9 m. Take 47 d. 9 m. from

from your Chord, and ſet them from M to 8, and from M to 4, and alſo from L to 8, and from L to 4. Alſo ſeeing that the Hour-Diſtances of VII and V are diſtant from the Meridian 66 d. 42 m. take them alſo out of your Line of Chords, and ſet them from M to 7, and from M to 5, and alſo from L to 7, and from L to 5.

Laſtly, The Stile of the Dial muſt make an Angle of 38 d. 30 m. equal to the Complement of the Latitude, and muſt ſtand upon the obſcure Hour-line of 12 at Night, and muſt point upwards towards the North-Pole, as the South Dials did downwards towards the South-Pole. And ſo have you finiſh'd your Dial.

CHAP. VIII.

How to make an Eaſt or Weſt DIAL.

THESE Dial Plains lying in the very Plain of the Meridian Circle, in which Circle the Poles of the World are placed, neither Pole can have any Elevation upon them, and therefore the Hour-lines can make no Angles at the Pole; and therefore the Hour-lines do not meet in a Centre, but are all parallel one to another. So that for this Dial there will need no Arithmetical Calculation, and therefore we will proceed to

The Geometrical Conſtruction of theſe Dials.

FIG. IV. Let A B C D be a Dial Plain, upon which you would draw an Eaſt or Weſt direct Dial.

1. Upon the point C, at the lowermoſt corner, if it be an Eaſt Dial, or upon the point D at the other lowermoſt corner, if it be a Weſt Dial, with 60 d. of your Line of Chords deſcribe an obſcure Arch of a Circle E F: then from the ſame Line of Chords take 38 d. 30 m. the Complement of the Latitude of the Place, (which is alſo the Elevation of the Equinoctial Circle above the Horizon) and ſet that Diſtance upon the Arch from E to F, and draw the Line C F quite through the Plain, which Line ſhall repreſent the Equinoctial Circle.

2. That you may the better proportion your Stile to your Plain, and that all the Hours may come on, and be at a convenient Diſtance one from another, aſſume two points in the Equinoctial Line, one towards the end C, for the Hour of 11 in the Eaſt Dial, (or of 1 in the Weſt Dial) as the point G, and another towards the other end thereof for the Hour of 6, as the point H; and through theſe two points,

points, G and H, draw two Lines at right Angles to the Equinoctial Line, for the Hour-lines of XI and VI a Clock.

3. Upon the point G with 60 deg. of the Line of Chords describe an obscure Arch of a Circle, (below the Equinoctial Line) as I K, setting thereon 15. d. of your Line of Chords, from I to K, and draw the obscure Line G K, extending it till it cut the Hour-line of VI in the point L; so shall the Distance L H be the Height of the perpendicular Stile proportioned to this Plain.

4. Open your Compasses to 60 d. of your Line of Chords, and setting one Foot in the point L, with the other describe an obscure Arch of a Circle M N between the Hour-line of VI and the Line G L.

5. Divide the Arch M N into five equal Parts (which 15 deg. of your Line of Chords will do) at the points ☉☉☉☉☉, and lay a Ruler from L to each of these points ☉☉☉☉☉, and the Ruler shall cut the Equinoctial Line C H in the points ✶✶✶✶, through which points draw right Lines parallel to the Hour-line of VI, as the Lines VII ✶ VII, VIII ✶ VIII, IX ✶ IX, X ✶ X, and they shall be the true Hour-lines of an East Plain, from Six in the Morning to Eleven before Noon.

6. For the Hour lines before VI, namely of IV and V in the Morning, you may put them on by transferring the same Distances upon the Equinoctial Line before VI, as there is between VI, and the Hour-lines of VII and VIII after VI, and through those points draw Lines parallel to the Hour-line of VI, and they shall be the Hour-lines of IV and V in the Morning.

7. For the Stile of these East or West Dials, it may be either a streight Pin or Wire pointed of the just length of the Line H O, or H L, fixed in the point H, or some other part of the Line of VI, perpendicularly to the Plain, which will shew the true Hour only by the Shadow of the very Top thereof. ---- Or (which is better) it may be a Plate of Brass or Iron, of the same Breadth as is the Distance between the Hour-lines of VI and IX upon the Equinoctial; which Plate must be set perpendicularly upon the Hour-line of VI, and so shall it shew the Hour by the Shadow of the upper edge thereof: and so is your Dial finished.

8. If you would insert the Halfs and Quarters of Hours into these Dials, you may easily effect it, by dividing each Space between ☉ and ☉ on the Arch M N into four equal parts, and so transferring them to the Equinoctial Circle, as you did the whole Hours. All which may be plainly seen in the Figure.

In the making of this Dial you have made two Dials, namely, a West Dial as well as an East, for it is the same in all respects as to the Hour-distances and height of the Stile. ---- Only whereas the Arch E F in the East Dial (through which the Equinoctial passeth) was described on the right hand of the Plain, upon the Centre C, in the West Dial it must be described on the left hand, upon the Centre D: and the Hour-lines of IV, V, VI, VII, VIII, IX, X and XI

In the Forenoon on the East Dial, must be VIII, VII, VI, V, IV, III, II and I in the Afternoon on the West Dial: and this is all the Variation.

And here you may take notice that these five Dials last described, namely, the Horizontal, South, North, East and West, may be made upon a Stone cut in a Cubick Form.

CHAP. IX.

How to make an Upright Declining DIAL in any Latitude.

IT was sufficient for the making of any of the five forementioned sorts of Dials, to know only the Latitude of the Place where the Dial is to stand; but in these the Quantity of the Declination, and the Coast to which the Plain declineth, is also necessary: and besides, these two being given, four other things must be found before the Dial can be drawn, *viz.*

1. The Height of the Pole (or Stile) above the Plain.
2. The Distance of the Substile from the Meridian.
3. The Plain's Difference of Longitude.
4. The Angle that each Hour-line maketh with the Substile.

All which shall be here taught how to be found, both by the Tables of Sines and Tangents, and also by the Lines on the Index of the Table.

Let it therefore be required in the Latitude of *London* (which is 51 deg. 30 min.) to make a South Dial declining Eastward 30 deg.

The Arithmetical Calculation of this Dial.

By the Tables of Sines.

I. *To find the Height of the Pole or Stile above the Plain.*

The ANAOLOGY is,

As the Sine of 90 deg. ------ ----- ---- ------	10	00000
is to the Sine Complement of the Latit. 38 d. 30 m.	9	79414
So is the Sine Complement of the Plain's Declin. 60 d.	9	93753
to the Sine of 32 deg. 37 min. ---- ---- -----	9	73167

Which 32 d. 37 m. is the height of the Pole, or Stile, above the Plain.

By

By the Line of Sines.

Extend the Compaſſes from the Sine of 90 deg. to the Sine of 38 deg. 30 min. the ſame Extent will reach from the Sine of 60 deg. to the Sine of 52 deg. 37 min. as before.

And that is the height of the Pole (or Stile) above the Plain.

II. *To find the Diſtance of the Subſtile from the Meridian.*

By the Table of Sines and Tangents.

The ANALOGY.

As the Sine of 90 deg. ---- ---- ---- ---- ----	10	00000
is to the Sine of the Plain's Declination 30 deg. ---	9	69897
So is the Tangent of the Complement of the Latitude of the Place 38 d. 30 m. ---- ----- ----	9	90060
to the Tangent of 21 d. 41 m. -- - - - -	9	59957

Which 21 d. 41 m. is the Diſtance of the Subſtile from the Meridian.

By the Lines of Sines and Tangents.

Extend the Compaſſes from the Sine of 90 d. to the Sine of 30 d. the ſame Extent will reach from the Tangent of 38 d. 30 m. to the Tangent of 21 d. 41 m. the Subſtile's Diſtance from the Meridian.

III. *To find the Plain's Difference of Longitude.*

By the Table of Sines.

The ANALOGY.

As the Sine Complement of the Latitude 38 d. 30 m. -	9	79414
is to the Sine of 90 d. - - - - - - - - - --	10	00000
So is the Sine of the Subſtile's Diſtance from the the Meridian 21 d. 20 m. - - - - - -	9	56758
	19	56758
To the Sine of 36 d. 25 m. - - - - - -- --	9	77344

Which 36 d. 25 m. is the Plain's Difference of Longitude.

By the Line of Sines.

Extend the Compaſſes from the Sine of 38 d. 30 m. upwards to the Sine of 90 d. the ſame Extent will reach from the Sine of 21 d. 41 m.

41 m. to the Sine of 36 d. 25 m. the Plain's Difference of Longitude, as before.

A Table of the Hour-Distances of a South Dial, declining either to the East or West 30 *deg.* 00 *min.*

	D.	M.
Latitude of the Place --	51	30
Distance of Subst. & Meri.	21	41
Height of the Stile - -	32	37
Plain's differ. of Longit.	36	25

Hours for the East	Hours for the West	Hour-Distances at the Equinoct. D.	M.	True Hour-Distances on the Plain. D.	M.
III	IX	88	35	87	22
IV	VIII	73	35	61	20
V	VII	68	35	53	57
VI	VI	53	35	36	8
VII	V	38	35	23	16
VIII	IV	23	35	13	14
IX	III	8	35	4	36
		Substile.			
X	II	6	25	3	28
XI	I	21	25	11	56
XII	XII	36	25	21	41
I	XI	51	25	34	3
II	X	66	25	51	00
III	IX	81	25	74	21

From the Plain's Difference of Longitude thus found, allowing 15 degrees of the Equinoctial for one hour, and one degree for four minutes of Time, it will follow that the Substile of the Dial (which is the Meridian of the Plain) must fall between the Hour-lines of 9 and 10 of the Clock in the Morning, because the Plain declineth Eastward; for the Plain's Difference of Longitude falling between 30 and 45 deg. (namely, between the second and third hour's Equinoctial Distance) there will be two compleat hours and 6 d. 25 min. more. Wherefore make a Table of the Hours fit for the Plain, as is here represented to the Eye, in which, against the Hour of XII, set the Plain's Difference of Longitude 36 deg. 25 min. from which substract 15 deg. and there will remain 21 deg. 25 min. which set against the Hour of XI, and from 21 deg. 25 min. substract 15 deg. and there will remain 6 deg. 25 min. which set against the Hour of X, and because it is less than 15 deg. write the word *Substile*, and substract 6 deg. 25 min. from 15 d. then will there remain 8 d. 35 m. which set above the word *Substile*, against the Hour of IX: To which by the continual Addition of 15 deg. will give you the Equinoctial Hour-distances of each Hour, as in the Table. Which Table being made, the next thing will be

IV. *To*

IV. *To find the Angle that each Hour maketh with the Subſtile.*

By the Tables of Sines and Tangents.

As the Sine of 90 d. - - - - - - - - - - - -	10	00000
is to the Sine of the height of the Pole above the Plain 32 d. 37 m. - - - - - - - - -	9	73160
So is the Tangent of the Equinoctial Diſtance of the next Hour to the Subſtile, *viz.* X. 6 d. 25 m.	9	05101
to the Tangent of 3 d. 28 m. - - - - - - - -	8	78261

Which 3 d. 28 min. is the Diſtance of Ten or Two a-Clock Hour-lines from the Subſtile. So again,

As the Sine of 90 d. -- -- - - - - - - - - -	10	00000
to the Sine of the Stile's height 32 d. 37 m. - -	9	73160
So the Tangent of the next Equinoctial Diſt. 21 d. 25 m.	9	59354
to the Tangent of 11 d. 56 m. - - - - - - - -	9	32514

Which 11 d. 56 m. is the Diſtance of the Hour-lines of Eleven and One of the Clock from the Subſtile. And ſo of all the reſt, as in the Table.

By the Lines of Sines and Tangents.

This Table may be made more eaſily by the Lines of Sines and Tangents by one opening of the Compaſſes, in this manner:

Extend the Compaſſes from the Sine of 90 d. to the Sine of 32 d. 37 m. (the height of the Stile, or Pole, above the Plain). The ſame Extent will reach from the Tangent of 6 d. 25 m. (which is the Equinoctial Diſtance of Ten and Two of the Clock) to the Tangent of 3 d. 28 m. the Tangent of the true Diſtance of the Hour-lines of Ten and Two of the Clock upon the Plain. --- And the ſame Extent will reach alſo from 21 d. 25 m. to 11 d. 56 m. the Diſtance of the Hours of Eleven and One. --- And from the Tangent of 36 d. 25 m. to the Tangent of 21 d. 41 m. for the Diſtance of Twelve a-Clock from the Subſtile. And ſo of the reſt, as in this Table.

The Geometrical Conſtruction of this DIAL.

FIG. V.

1. Upon the Plain you intend to deſcribe your Dial on, draw a downright or perpendicular Line O P, for the Meridian and Hour-line of XII.

2. Towards the upper part whereof, as at O, aſſign a point, as O, for the Centre of your Dial.

3. With 60 d. of your Line of Chords, upon O, deſcribe an obſcure Semicircle R S T.

4. Laying your Table before you, and there finding the Diſtance of the Subſtile from the Meridian to be 21 d. 41 m. take 21 d. 41 m. out of your Line of Chords, and ſet them from S to V, if the Plain decline Eaſtward, as here it doth; or from S to W, if the Plain had declined Weſtward; and draw the Line O V for the Subſtilar-line of your Dial.

5. Finding by your Table the height of the Pole or Stile above the Plain to be 32 d. 37 m. take that Number of Degrees out of your Line of Chords, and ſet them from V to X, and draw the Line O X, for the Stile of the Dial.

6. Seeing by your Table that the Hour-line of X of the Clock in the Eaſt-declining Plain, or of II of the Clock in the Weſt-declining Plain, are diſtant from the Subſtile 3 d. 28 m. take 3 d. 28 m. from your Chord, and ſet them from V to 10, and draw the Line O 10 X for the Hour-line of Ten of the Clock.

7. Take 11 d. 56 m. out of your Chord, and ſet them from V to 11, and draw the Line O 11 for the Hour-line of Eleven. Again,

	d.	m.						
	21	41		12	And draw the Lines	O	12 XII	for the Hour-lines of Twelve
	34	03		1		O	1 I	One
	51	00	out of	2		O	2 II	Two
	74	21	your Line	3		O	3 III	Three
	4	36	of Chords,	9		O	9 IX	Nine
Take	13	14	and ſet	8		O	8 VIII	Eight
	23	16	them from	7		O	7 VII	Seven
	36	08	V to	6		O	6 VI	Six
	53	57		5		O	5 V	Five
	61	20		4		O	4 IV	Four
	87	22		3		O	3 III	Three

And ſo is your Dial finiſhed.

The Stile muſt ſtand directly upon the Subſtile, and muſt make an Angle therewith equal to the Angle X O V, namely 32 d. 37 m. equal to the height of the Pole above the Plain.

The Weſt-declining Dial is the ſame as the Eaſt-decliner; only the Subſtile muſt ſtand on the contrary ſide of XII to what now it doth, and the Names of the Hours muſt be changed, (all but Twelve) for XI muſt be I, and X muſt be II, *&c.* at is before hinted.

And in making of the South Dials you have alſo made the North Dials; for the South Dial being turned upſide-down, ſo that the Stiles thereof may point upwards to the North Pole, and the Hours about Twelve at Night omitted, the North Dials are alſo finiſhed. And now I ſhall proceed to ſhew you

CHAP.

CHAP. X.

How to draw a Dial upon an upright Plain, declining many Degrees towards either the Eaſt or Weſt, whereby the Pole will have but ſmall Elevation, (and conſequently the Hours run cloſe together) ſo that the Center of the Dial muſt (of neceſſity) be omitted.

FOR an Example of this kind, let us ſuppoſe a Plain beholding the South to decline therefrom Weſtward 85 d. wherefore obſerving the former Rules and Canons, the other Requiſites will be found to be as in this little Table following, *viz.*

		d.	m.
	Latitude of the Place - - - - - - - -	51	30
	Declination Weſtward - - - - - - - -	85	00
The	Diſtance of the Subſtile and Meridian --	38	23
The	Height of the (Pole or) Stile - - - -	03	06
The	Plain's Difference of Longitude - -- -	86	15

Theſe Requiſites being obtained as afore taught, either by the Canons of Sines and Tangents, or by the Lines of Sines and Tangents upon the Index, the Equinoctial Hour-Diſtances (by the continual Addition of 15 d. for an Hour) will be found as in the ſecond Column of this Table, and the true Hour-Diſtances upon the Plain to be ſuch as is expreſſed in the third Column, in which (by reaſon of the Greatneſs of the Plain's Difference of Longitude) the Hour-Diſtances near the Subſtile fall ſo near together, that (except they be extended far from the Center) they will have no competent Diſtance (or Space) betwixt each other. Wherefore the old uſual Way hath been to draw the Dial upon a large Floor, (or the like) and to cut off the Hour-lines, (ſo many as are neceſſary) Stile and Subſtile alſo, till they will competently fill the Plain upon which the Dial is to be deſcribed.

To prevent which Trouble and Inconvenience alſo, I will ſhew you how ſuch Dials that have great Declination (after the common Requiſites are obtained) may be drawn, and that in a little room, which may be augmented or diminiſhed as occaſion ſhall require. And thus quitting Calculation, I ſhall proceed to

The

	D.	M.
South declining Weſt -	85	00
Diſt. Subſtile and Merid.	38	23
Stile's height - - - - -	03	06
Pl. differ. of Longitude	86	05

Hours.	Equinoctial Diſtances.		True Diſtances.	
	D.	M.	D.	M.
XII	86	05	33	23
XI	71	05	9	06
X	56	35	4	36
IX	41	05	2	42
VIII	26	05	1	31
VII	11	05	0	30
The Subſtile's place.				
VI	3	55	0	13
V	18	55	1	04
IV	33	55	2	05
III	48	55	3	33
II	63	55	6	20
I	78	55	15	28

The Geometrical Projection of this (or the like) DIAL.

FIG. VI.

1. Draw a right Line A B perpendicular to one ſide of your Plain, and towards the left hand, becauſe the Plain declineth Weſtwards; and with 60 d. of your Line of Chords deſcribe an obſcure Arch of a Circle C D E, and upon it (from C to D) ſet off 38 d. 23 m. the Subſtile Diſtance from the Meridian, and draw the Line A D for the Subſtile, quite through the Plain.

2. Out of your Line of Chords take 3 d. 6 m. the height of the Stile, and ſet them upon the former Arch from D to E, and draw the Line A E for the Stile.

3. Now becauſe the Stile is but of ſmall Elevation, (*viz.* but 3 d. 6 m.) draw another Line (as G H) parallel to the Line of the Stile A E, at ſuch convenient Diſtance as you ſhall think fit; which ſhall be your augmented Stile.

4. Aſſume any two points in the Subſtilar-line A D, at ſome convenient Diſtance to each other, as R S, and through theſe two points draw two infinite right Lines, both of them at right Angles to the Subſtilar-line A D, as the Lines z z, and x x.

5. From the point R with your Compaſſes take the neareſt Diſtance to the new augmented Stile G H, and ſet that Diſtance upon the Subſtilar-line from R to K.——Alſo from the point S take the neareſt Diſtance to the new augmented Stile G H, and ſet that Diſtance alſo upon the new Subſtile from S to L.

6. Upon theſe two points K and L with 60 deg. of the Line of Chords deſcribe two Semicircles, and in either of them ſet off 86 deg. 5 min. the Plain's Difference of Longitude; as from R to M, and alſo from S to M; both of them on the ſame ſide of the Subſtilar-line on which the firſt perpendicular line A B was drawn.

7. Divide either of the Semicircles laſt drawn into 12 equal parts, beginning at the point M, at the points ⊙⊙⊙, *&c*, which 15 deg. of the Line of Chords will effect.

8. Lay a Ruler to the point L, and the reſpective points ⊙⊙⊙, *&c.* and the Ruler will cut the Line X X in the points ✱✱✱, *&c.* --- Alſo lay a Ruler to K, and the ſeveral points ⊙⊙⊙, *&c.* and the Ruler will cut the Line Z Z in the ſeveral points ✱✱✱, *&c.*

Laſtly,

Laſtly, Lines drawn from the firſt point * in the Line z z, to the firſt point * in the other Line x x, (which the Subſtilar-line will direct you how to do) theſe Lines ſo drawn ſhall be the true Hour-lines proper for the Plain, and will appear as in the Figure, and be at a competent Diſtance one from another, without having any relation at all to the Centre.

Now in the making of this Dial you have made four Dials, *viz.*

a { South declining Weſt, South declining Eaſt, North declining Weſt, North declining Eaſt } 85 degrees;

only by changing of the Names of the Hours, and placing the Stile on the contrary ſide of the Line A B, for the South declining Eaſt: And by turning of the Dial upſide downwards, for the two North Decliners, ſo that the Stiles may point upwards to the North Pole, and the Hours about Midnight omitted, as in the former Section.

CHAP. XI.

Concerning direct Reclining and Inclining Dials.

I. *Of Eaſt or Weſt Reclining ond Inclining Dials.*

FOR the drawing of theſe Dials, the beſt Way will be to refer them to a new Latitude, where they may become upright declining Plains; and that may be known thus: For,

1. The new Latitude will always be the ſame with the Complement of the Latitude in which the Plain reclineth. And,
2. The new Declination in that new Latitude will be always the ſame with the Complement of the Plain's Reclination.

So that in the Latitude of *London* 51 d. 30 m. if an Eaſt or Weſt Plain ſhould recline from the Zenith 35 d. and you would know in what Latitude that Plain ſhall be an upright declining Plain:

1. The new Latitude is 38 d. 30 m. which is the Complement of the known Latitude.
2. The new Declination will be 55 d. which is the Complement of (35 d.) the Plain's Reclination.

So that if by the Rules of the two foregoing Chapters you do make an upright Dial for the Latitude of 38 d. 30 m. declining 55 d. that Dial ſhall be a true Dial for an Eaſt or Weſt Plain that reclineth 35 d. in the Latitude of 51 d. 30 m. Only this is to be taken notice of, *viz.*

That in all upright declining Plains the Hour-line of 12 a-clock is a perpendicular or plumb Line; ſo the Hour-line of 12 in all Eaſt and

Weſt reclining and inclining Plains muſt be an Horizontal or level Line, as the Line of 6 a-clock is in the North or South Plains.

And note alſo, that the Stiles of all Eaſt and Weſt reclining Plains muſt point upwards towards the North Pole, (in theſe North Latitudes) and the Stiles of all Eaſt and Weſt inclining Dials muſt point downwards towards the South Pole.

II. *Of direct South Reclining and North Inclining Plains.*

For the drawing of Hour-lines upon theſe kind of Plains, it is requiſite to refer them to a new Latitude, in which they may be Horizontal Plains; which may be thus done: For,

1. If the Reclination of the Plain be leſs than the Complement of the known Latitude, ſubſtract the Reclination out of the Complement of the known Latitude, and the Remainder ſhall be the new Latitude.

So, a South Plain in the Latitude of 51 d. 30 m. reclining 20 d. ſhall be an Horizontal Dial in the Latitude of 18 d. 30 m. for 20 d. being ſubſtracted from 38 d. 30 m. there will remain 18 d. 30 m. for the new Latitude. So that an Horizontal Dial made (by the Rules before-going) for the Latitude of 18 d. 30 m. will ſerve for a South Plain reclining 20 d. in the Latitude of 51 d. 30 m.

2. If the Reclination of the South Plain be greater than the Complement of the known Latitude, ſubſtract the Complement of the Latitude from the Plain's Reclination, and the Remainder ſhall be the new Latitude.

So, a South Plain in the Latitude of 51 d. 30 m. which reclines 68 d. ſhall be an Horizontal Dial in the Latitude of 29 d. 30 m. for if you ſubſtract 39 d. 30 m. the Complement of the known Latitude, from 68 d. the Plain's Reclination, there will remain 29 d. 30 m. And ſo an Horizontal Dial made for the Latitude of 29 d. 30 m. will ſerve for a South Plain reclining 68 d. in the Latitude of 51 d. 30 m.

3. If the Reclination of the South Plain be equal to the Complement of the known Latitude, then doth ſuch a Plain lie directly in the prime Vertical Circle, and parallel to the Axis of the World; and ſo the new Latitude is 00 d. 00 m.

Wherefore the Pole hath no Elevation above ſuch a Plain, and a Dial for ſuch a Plain muſt be made in all reſpects as an Eaſt or Weſt Dial is made; only the Hour line of Six in the Eaſt or Weſt Dial muſt in this be the Hour-line of Twelve, and the Equinoctial Line in this Dial muſt be the ſame with the Horizontal Line, and the height (or rather breadth) of the Stile muſt be equal to the Diſtance that is between the Hour-lines of Twelve and Nine or Three.

The North Inclining Dials are the ſame with the South Recliners oppoſite to them; only the naming of the Hours muſt be changed: And for the Stiles, if the North Pole be elevated upon the reclining Plain, the South Pole muſt be elevated upon the inclining Plain oppoſite thereunto, and the contrary.

III. *Of*

III. *Of direct North Reclining and South Inclining Plains.*

Theſe Plains alſo muſt be referred to a new Latitude, where they muſt become Horizontal Plains; which may thus be performed:

1. Add the Complement of the known Latitude and the Reclination of the Plain together, the Sum of them ſhall be the new Latitude.

Thus, in the Latitude of 51 d. 30 m. a North Plain reclining 20 d. will be an Horizontal Plain in the Latitude of 58 d. 30 m. for 38 d. 30 m. the Complement of the Latitude, added to 20 d. the Plain's Reclination, make 58 d. 30 m. And ſo an Horizontal Dial made for the Latitude of 58 d. 30 m. will ſerve for a North Dial reclining 20 d. in the Latitude of 51 d. 30 m. But,

2. If the Sum of the Complement of the known Latitude and the Plain's Reclination do exceed 90 d. ſubſtract the Sum of them from 180 d. and the Remainder ſhall be the new Latitude.

So, a North Plain in the Latitude of 51 d. 30 m. reclining 68 d. will be an Horizontal Plain in the Latitude of 73 d. 30 m. for if you add 38 d. 30 m. (the Comp. of the Latitude) to 68 d. (the Reclination of the Plain) the Sum of them will be 106 deg. 30 m. which (being above 90 d.) take from 180 d. and the Remainder will be 73 d. 30 m. And an Horizontal Dial for that Latitude will be a Dial for a North reclining Plain 68 d. in the Latitude of 51 d. 30 m.

3. If the Reclination of the North Plain be equal to the Latitude 51 d. 30 m. (in our Example) then the Reclination of the Plain and the Complement of the Latitude added together will make 90 d. for the new Latitude.

So ſhall ſuch a Plain lie parallel to the Equinoctial in the Sphere. And to make a Dial for ſuch a Plain, you have no more to do than to divide a Circle into 24 equal parts, and drawing lines from the Center to each of thoſe equal parts, they ſhall be the true Hour-lines for ſuch a reclining Plain. And for the Stile, it is to be no other than a ſtraight Wire ſet upright in the Center of the Circle, and ſo is your Dial finiſh'd.

And thus have I ſhew'd you how to deſcribe Hour-lines upon all ſorts of upright Plains, both direct and declining, (which of all others are the moſt uſual) in any Latitude, and that by the moſt exact and abſolute way, namely by Calculation, which for Exactneſs exceedeth all others: As alſo upon all direct *Eaſt*, *Weſt*, *North* and *South reclining* and *inclining* Plains, whereby Dials may be drawn upon many Polyhedronick Bodies, cut out in Stone or Timber.

And now it may be expected that I ſhould ſay ſomething of *Declining*, *Reclining*, or *Inclining Plains:* But having treated of theſe at large in a particular Treatiſe of DIALLING, (perform'd three ſeveral ways, namely, *Arithmetically*, *Geometrically*, and *Inſtrumentally*) lately by me publiſhed, I ſhall ſay no more of *Dialling* in this

this place; but for farther Satisfaction therein, refer you to the forementioned Treatiſe. But before I conclude this Book, I ſhall ſhew you ſome other ways whereby the Hour may be obtained, not only by the Sun in the Day-time, but by the Fixed Stars alſo in the Night-ſeaſon.

CHAP. XII.

How to find the Hour of the Day by help of a Walking-Staff (or other ſtraight Thing) divided into 10 *or* 100 *equal Parts.*

YOUR Staff, or other ſtraight Thing, being divided firſt into 10 equal Parts, and then each of thoſe into 10 other equal Parts, ſo will the Staff be divided into 100 equal Parts; which being ſo divided and figured, erect Perpendicular upon ſome plain, level Ground, and note the Place where the Shadow terminates. Then with your Staff meaſure the Length of the Shadow thereof in Staves Lengths, and hundred Parts of one Length, according as it is numbered.

This done, in the following Table ſeek the Day of the Month, (or the neareſt thereunto) and caſt your Eye along that Line againſt which the Day of the Month ſtandeth, 'till you find the Length of the Shadow of your Staff as you meaſured it upon the Ground: Which found, (or the neareſt to it) at the Top or Head of the Table you ſhall find the Hour of the Day, either before or after Noon.

A Table

A Table by which you may find the true Hour of the Day by a Staff (or the like) divided into 10 *or* 100 *equal Parts.*

Hours: Before noon / After noon	XII		XI / I		X / II		IX / III		VIII / IV		VII / V		VI / VI		V / VII	
Every fifth Day of the Year.	Staves Length	100 Parts	Staves Length	100 Parts	Staves Length	100 Parts	Staves Length	100 Parts	Staves Length	100 Parts	Staves Length	100 Parts	Staves Length	100 Parts	Staves Length	100 Parts
June 11 / July 11	0	55	0	60	0	75	0	98	1	34	1	92	3	0	5	72
June 6 / July 16	0	56	0	61	0	75	0	99	1	35	1	93	3	1	5	80
June 1 / July 21	0	56	0	61	0	76	0	99	1	36	1	95	3	4	5	90
June 26 / July 26	0	57	0	62	0	77	1	1	1	38	1	98	3	12	6	18
May 21 / August 1	0	59	0	64	0	79	1	3	1	41	2	2	3	21	6	52
May 16 / August 6	0	61	0	66	0	81	1	6	1	44	2	8	3	35	7	11
May 11 / August 11	0	63	0	68	0	83	1	8	1	48	2	14	3	51	7	86
May 6 / August 16	0	66	0	71	0	86	1	12	1	53	2	24	3	73	9	6
May 1 / August 21	0	69	0	74	0	90	1	16	1	59	2	34	4	0	10	78
May 26 / August 26	0	73	0	78	0	94	1	21	1	66	2	47	4	36	13	84
April 21 / September 1	0	77	0	82	0	98	1	27	1	74	2	62	4	81	19	63
April 16 / September 6	0	82	0	87	1	4	1	33	1	84	2	81	5	43	35	80
April 11 / September 11	0	87	0	92	1	9	1	40	1	95	3	3	6	23	86	40
April 6 / September 16	0	93	0	98	1	16	1	49	2	8	3	31	7	43		
April 1 / September 21	0	99	1	5	1	23	1	58	2	22	3	65	9	22		
April 26 / September 26	1	6	1	12	1	31	1	69	2	40	4	7	12	18		
March 21 / October 1	1	13	1	20	1	40	1	81	2	60	4	60	18	17		
March 16 / October 6	1	21	1	28	1	50	1	94	2	84	5	31	36	37		
March 11 / October 11	1	30	1	37	1	61	2	9	3	13	6	27				
March 6 / October 16	1	40	1	48	1	73	2	27	3	47	7	63				
March 1 / October 21	1	51	1	59	1	87	2	47	3	89	9	73				
March 26 / October 26	1	63	1	72	2	2	2	71	4	41	13	30				
February 21 / November 1	1	76	1	86	2	19	2	98	5	8	20	94				
February 16 / November 6	1	89	2	0	2	38	3	29	5	92						
February 11 / November 11	2	5	2	17	2	61	3	66	7	8						
February 6 / November 16	2	21	2	35	2	84	4	8	8	62						
February 1 / November 21	2	39	2	55	3	11	4	59	10	98						
January 26 / December 26	2	58	2	76	3	39	5	18	14	51						
January 21 / December 1	2	79	2	99	3	71	5	89	20	81						
January 16 / December 6	3	0	3	21	4	5	6	68	34	37						
January 11 / December 11	3	21	3	46	4	40	7	60	82	84						
January 6 / December 16	3	41	3	68	4	76	8	63								
January 1 / December 21	3	60	3	91	5	11	9	72								
December 26	3	76	4	9	5	42	10	79								
December 21	3	91	4	25	5	66	11	73								
December 16	3	97	4	33	5	82	12	38								
December 11	4	1	4	37	5	90	12	64								

The Uſe of the Table.

Example 1. Suppoſe that upon the 6th of *May* I erect my Staff perpendicular, and meaſuring the length of the Shadow thereof, I find the Shadow to contain two times the length of my Staff, and 24 Parts more. Wherefore I look in my Table firſt for the 6th Day of *May*, which I find in the firſt Column of my Table, and caſting my Eye along that Line towards my right hand I find 2 24, over which at the Head of the Table there ſtands VII V; which ſhews that it is VII of the Clock in the Morning (if you made your Obſervation in the Forenoon), or V in the Evening (if your Obſervation was in the Afternoon).

In like manner, if this Obſervation had been made upon the 16th of *July*, and the length of the Shadow the ſame, *viz.* 2 24 Parts, the Hour would then have been the ſame: For by the Table you may plainly ſee, that one and the ſame Line ſerves both for the 6th of *May* and the 16th of *July*; and alſo the ſame Line that ſerves for the 21ſt of *February*, ſerves alſo for the 1ſt of *October*, which Days are of equal length.

Example 2. Again, Upon the 16th of *April* (or the 6th of *Auguſt*) I erect my Staff, and find the length of the Shadow thereof to contain once its length, and 30 Parts more: I look in the Line that ſtands againſt the 16th of *April*, or 6th of *Auguſt*, for the length of my Shadow, *viz.* 1 30, but I cannot find it, but the neareſt thereunto is 1 33, over which there ſtands IX and III; which ſhews the neareſt Hour to be IX in the Morning, or III in the Afternoon.

Now becauſe the length of your Shadow was leſs than the Number that you found in the Table, you may conclude that if it were in the Forenoon, that it was a ſmall matter paſt IX, becauſe the Sun was higher than you find in the Table, and ſo conſequently the Shadow ſhorter: But had it been in the Afternoon, it had wanted a ſmall matter of III in the Afternoon, for the Reaſon aforeſaid.

Example 3. Again, Upon the 26th of *May*, or the 26th of *June*, I find the length of the Shadow of my Staff to be once its length, and 20 Parts more. If I ſeek for this length againſt my Day, I cannot find it, but I find 1 1 in that Line to ſtand under IX and III, which is too little; and I find in the ſame Line 1 38 to ſtand under VIII and IV, which is too much: Wherefore I take 20, my odd Parts from 38, the greater Number of Parts, and there remains 18 Parts. Then ſeeing that the length of the Shadow in one Hour's time increaſes 37 Parts of a Staff, I ſay, by the Rule of Proportion,

If

If 37 Parts of Shadow give 60 Min. or one Hour, what ſhall 20 Parts of Shadow give?

parts min. parts min.
As 37 is to 60, ſo is 20 to 32

20

37) 1200 (32

111

90

74
16

So that you may conclude the Hour to be either 32 min. paſt VIII in the Morning, or wanting 32 min. of III in the Afternoon.

					in the Morn.		in the Aftern.
And thus upon	January 16	if the length of the Shadow be	3 21	the hour will be either	XI	or	I
	February 26		2 2		X		II
	March 11		2 9		IX		III
	April 1		3 65		VII		V
	December 11		4 37		XI		I
	May 11		0 63	the hour will be XII at Noon.			

And thus much for the Uſe of this Table.

CHAP. XIII.

How to find the Hour of the Night by the Fixed Stars.

FOR this purpoſe the two following *Tables* are ſubſervient. The Firſt whereof containeth the *Right Aſcenſion* and *Semidiurnal Arch* of 80 principal *Fixed Stars*, ſo orderly placed, by their difference of *Aſcenſion*, that at all times *one* or *other* is either *Riſing*, *Setting*, or upon (or near) the *Meridian*.

The Second ſhews the *Right Aſcenſion* of the *Sun* for every Day of the Year. And the *Uſe* of theſe *Tables* is twofold. For,

Firſt, They direct you to find at what hour and min. any of the ſaid *Stars* in the firſt *Table* will be upon the South part of the Meridian: Or, if you ſee any of them upon the South part of the Meridian, they will direct you to the hour of the Night.

Secondly, They ſhew alſo at what hour and min. any Day in the Year any of the ſaid *Stars* do *riſe* or *ſet*: So that ſeeing any of them *riſing* in the *Eaſt*, or *ſetting* in the *Weſt*, you may from thence compute the exact hour or time of the Night. As by *Examples* following ſhall be made to appear.

A Ta-

A Table ſhewing the right Aſcenſion and Semidiurnal Arch of 80 of the moſt eminent Fixed Stars in Hours and Minutes.

Names of the Stars.	Right Aſcenſion.	Semidiurnal Arch.	Names of the Stars.	Right Aſcenſion.	Semidiurnal Arch.
	H. M.	H. M.		H. M	H. M.
Schedir in Caſſiopea	0 22	Sets not	Hydra's Head	9 12	6 38
Southermoſt in Whale's Tail	0 27	4 4	Lion's Heart	9 50	7 14
Star in the Hexion of Caſſiopea	0 37	Sets not	* in the hin. part of Lion's Neck	9 58	8 32
Girdle of Andromeda	0 51	10 6	Lion's Tail	11 32	7 32
Caſſiopea's Knee	1 5	Sets not	Virgin's Girdle	12 39	6 28
In the North knot of ♓	1 14	4 45	Vindemiatrix	12 40	7 9
Former Horn of the Ram	1 36	7 39	Virgin's Spike	13 8	5 11
Belly of the Whale	1 36	4 56	Arcturus	14 1	8 2
Hindermoſt Horn of the Ram	1 37	7 49	Bootes left Shoulder	14 19	Sets not
Andromeda's South Foot	1 43	Sets not	South } Balance	14 33	4 40
Bright * in the Ram's Head	1 49	8 7	North } Balance	15 0	5 17
Middlemoſt * in Ram's Tail	1 56	7 53	Bright * in the Crown	15 25	8 57
Whale's Jaw	2 45	5 45	Bright * in the Serpent's Neck	15 29	6 40
Meduſa's Head, *Algol*	2 47	Sets not	Scorpion's Heart, *Antares*	16 9	3 23
Perſeus right Side	2 51	Sets not	Hercules right Shoulder	16 16	8 10
Brighteſt of the 7 *'s *Pleiades*	3 28	8 16	Left } Knee of Ophiuchus	16 19	5 8
North Eye of the Bull	4 9	7 44	Right } Knee of Ophiuchus	16 46	4 36
South Eye, *Aldebaran*	4 17	7 27	Hercules Head	16 59	7 22
South Horn of the Bull	4 32	7 43	Ophiuchus Head	17 20	7 10
The Goat	4 52	Sets not	Bright * in the Dragon's Head	17 50	Sets not
Orion's Foot, *Regel*	4 59	5 14	Bright * in the Harp	18 22	Sets not
North Horn of the Bull	5 6	9 0	Vulture's Tail	18 51	7 14
Foremoſt Shoulder of Orion	5 8	6 32	Swan's Bill	19 18	8 51
Firſt in Orion's Girdle	5 16	5 57	Bright * of the Vulture	19 35	6 43
Orion's Head	5 17	8 1	Uppermoſt Wing of the Swan	19 35	Sets not
South Horn of the Bull	5 18	8 1	Uppermoſt } Horn of the Goat	20 0	4 46
Second in Orion's Girdle	5 20	5 52	Lowermoſt } Horn of the Goat	20 3	4 33
Lowermoſt in Orion's Girdle	5 24	5 49	Swan's Breaſt	20 11	Sets not
Auriga's right Shoulder	5 36	Sets not	Waterbearer's left Hand	20 29	5 3
Following Shoulder of Orion	5 38	6 39	Swan's Tail	20 31	Sets not
Right Hand of Orion	5 49	7 21	Lowermoſt Wing of the Swan	20 33	9 48
The bright Foot of Gemini	6 19	7 32	Waterbearer's left Shoulder	21 13	5 23
The great Dog, *Sirius*	6 31	4 30	Cepheus Girdle	21 25	Sets not
* in the Belly of the great Dog	6 55	3 21	Pegaſus Mouth	21 28	6 44
* near the great Dog's Ear	7 7	4 52	Waterbearer's right Shoulder	21 47	5 50
The little Dog, *Procyon*	7 22	6 32	*Fomahaut*	22 39	2 28
Lowermoſt Head of the Twins	7 26	9 4	*Scheat*	22 48	8 42
Bright * in the Deck of the Ship	7 54	3 42	*Marchab*	22 49	7 13
North } Aſellus	8 23	8 14	Andromeda's Head	23 52	8 51
South } Aſellus	8 25	7 50	Bright * in Caſſiopea's Chair	23 53	Sets not

A Table

A Table shewing the Sun's Right Ascension in Hours and Minutes for every Day in the Year at Noon.

Days.	Janu.		Febr.		March		April		May		June		July		Aug.		Sept.		Octob.		Nov		Dec.	
	h.	m.	h.	m	h.	m	h.	m	h.	m.	h.	m	h.	m.	h.	m	h.	m.	h.	m	h.	m.	h.	m.
1	19	35	21	43	23	29	1	22	3	14	5	20	7	24	9	26	11	19	13	8	15	8	17	16
2	19	39	21	47	23	33	1	25	3	18	5	24	7	28	9	30	11	23	13	12	15	13	17	21
3	19	44	21	51	23	36	1	29	3	22	5	28	7	32	9	33	11	27	13	15	15	17	17	25
4	19	48	21	55	23	40	1	32	3	26	5	32	7	36	9	37	11	31	13	18	15	21	17	29
5	19	52	21	59	23	44	1	36	3	30	5	36	7	40	9	41	11	34	13	23	15	25	17	34
6	19	56	22	2	23	47	1	40	3	34	5	40	7	44	9	45	11	38	13	27	15	29	17	39
7	20	0	22	6	23	51	1	44	3	38	5	44	7	48	9	48	11	41	13	30	15	33	17	43
8	20	4	22	10	23	55	1	47	3	42	5	48	7	52	9	52	11	45	13	34	15	37	17	48
9	20	9	22	14	23	58	1	51	3	46	5	53	7	56	9	56	11	48	13	38	15	41	17	52
10	20	13	22	18	0	2	1	59	3	50	5	57	8	0	10	0	11	51	13	42	15	45	17	56
11	20	18	22	21	0	5	1	59	3	54	6	1	8	4	10	3	11	55	13	46	15	50	18	1
12	20	22	22	25	0	9	2	3	3	58	6	5	8	8	10	7	11	59	13	50	15	54	18	6
13	20	26	22	29	0	13	2	6	4	2	6	10	8	12	10	10	12	3	13	53	15	58	18	10
14	20	30	22	33	0	17	2	10	4	6	6	14	8	16	10	14	12	7	13	57	16	2	18	15
15	20	34	22	36	0	20	2	13	4	9	6	18	8	20	10	18	12	10	14	1	16	7	18	19
16	20	38	22	39	0	23	2	17	4	13	6	22	8	24	10	21	12	14	14	5	16	11	18	24
17	20	42	22	44	0	27	2	21	4	17	6	26	8	28	10	25	12	17	14	9	16	15	18	28
18	20	46	22	46	0	31	2	25	4	21	6	31	8	32	10	29	12	20	14	14	16	19	18	33
19	20	51	22	51	0	35	2	28	4	25	6	35	8	36	10	32	12	24	14	17	16	24	18	37
20	20	55	22	55	0	39	2	34	4	29	6	39	8	40	10	35	12	28	14	20	16	29	18	41
21	20	59	22	59	0	42	2	38	4	34	6	43	8	44	10	39	12	32	14	24	16	33	18	45
22	21	2	23	3	0	45	2	41	4	38	6	47	8	48	10	43	12	36	14	28	16	37	18	49
23	21	7	23	6	0	48	2	44	4	42	6	51	8	52	10	47	12	39	14	32	16	41	18	54
24	21	10	23	10	0	52	2	47	4	46	6	55	8	56	10	50	12	42	14	36	16	45	18	59
25	21	15	23	14	0	56	2	52	4	50	6	59	8	59	10	54	12	46	14	40	16	50	19	3
26	21	19	23	18	1	0	2	56	4	54	7	39	3	10	58	12	50	14	44	16	55	19	2	
27	21	23	23	22	1	33	0	4	5	8	7	8	9	7	11	1	12	53	14	48	16	59	19	16
28	21	27	23	26	1	7	3	45	2	7	12	9	10	11	4	12	57	14	52	17	3	19	17	
29	21	31			1	11	3	7	5	7	7	16	9	14	11	8	13	1	14	56	17	8	19	20
30	21	34			1	15	3	11	5	11	7	20	9	18	11	12	13	5	15	0	17	12	19	24
31	21	38			1	19			5	16			9	22	11	15			15	4			19	30

The Uſe of the two former Tables.

I. *To find* (*any Day in the Year*) *at what Hour and Minute any of the Stars mentioned in the firſt Table will be upon the South part of the Meridian.*

To effect this, ſubſtract the Right Aſcenſion of the Sun for the Day given, from the Right Aſcenſion of the Star whoſe Southing is required, and the Remainder is the time that that Star will be upon the Meridian that Night. --- But if the Sun's Right Aſcenſion be greater than the Right Aſcenſion of the Star, you muſt (always) in that caſe add 24 Hours to the Star's Right Aſcenſion, (ſo that Subſtraction may be made) and the Remainder will ſhew you at what Hour the next Morning the ſaid Star will be upon the South part of the Meridian.

EXAMPLE.

Let it be required upon the 27th of *March* to know at what time the *Pleiades*, or 7 Stars, will be upon the Meridian.

	H.	M.
The Right Aſcenſion of the *Pleiades* is	3	28
The Sun's Right Aſcenſion for the 27th of *March* is	1	3
Subſtraction being made, there remains	2	25

Wherefore upon the 27th of *March* the 7 Stars will be upon the South part of the Meridian at 25 min. after Two of the Clock in the Afternoon.

But if upon the 15th of *October* (the Sun's Right Aſcenſion then being 14 hours 1 min.) it were required to know at what hour the *Pleiades* or 7 Stars would be upon the Meridian: Then,

	H.	M.
The Right Aſcenſion of the *Pleiades* being	3	28
Add 24 Hours thereto, and it makes	27	28
The Sun's Right Aſcenſion for the 15th of *October* is	14	1
Subſtraction being made, there remains	13	27

From which 12 Hours being taken, there remains 1 Hour and 27 Min. So that the *Pleiades* will be upon the Meridian at 27 Min. after One in the Morning on the 16th of *October*, which is the Day following. Again,

If

If upon the ſame 15*th of* October *you ſhould have ſeen the* Great Dog *upon the Meridian, and would from thence find the Hour of the Night.*

	H.	M.
The Right Aſcenſion of the *Great Dog* is -- -- --	6	31
To which add 24 Hours, the Sum is - - - - - -	30	31
The Right Aſcenſion for *October* 15. is - - -- --	14	1
The Remainder is - -- - -- - - - - -	16	30

From which 12 Hours being taken, there remain 4 Hours 30 Min. for the true Time of the Night; that is, half an Hour after Four in the Morning the next Day.

II. *To find (any Day in the Year) at what Time any of the Stars mentioned in the firſt Table do riſe or ſet.*

Having (by the former Section) found at what Hour the Star will be upon the Meridian, if you add the Semidiurnal Ark of the Star to the Time of his being upon the Meridian, you have the Hour and Minute of that Star's *Setting*. And if from the Time of the Star's coming to the South you do ſubſtract the Semidiurnal Ark of the Star, you have the Hour and Minute of that Star's *Riſing*.

EXAMPLE.

Thus (by the former Section) you found upon the 27th of *March*,

	H.	M.	
The *Pleiades* were upon the Meridian at - -	2	25	afternoon
The Semidiurnal Ark of the *Pleiades* is -- --	8	16	
The Sum is - - - - -	10	41	at night.

At which time the *Pleiades* or 7 Stars do ſet upon the 27th of *March*;

	H.	M.
And by ſubſtracting the Semidiurnal Ark -- --	8	16
from 2 H. 25 M. (the Time of Southing) adding 12 H. becauſe Subſtraction cannot elſe be made,	14	25
There remains - - - -	6	09

So that the *Pleiades* (upon the 27th of *March*) do riſe at Nine Minutes after Six in the Morning. Again,

Upon

Upon the 15*th of* October.

	H.	M.
The Time of the *Pleiades* coming to the South was --	13	27
To which add the Semidiurnal Ark - - - - - - --	8	16
The Sum is - - - - - --	21	43
From which ſubſtract - - - - - - - -	12	00
There remains - - - - --	9	43

So that the *Pleiades* do ſet at 43 min. paſt 9 of the Clock the next Morning.

Likewiſe,

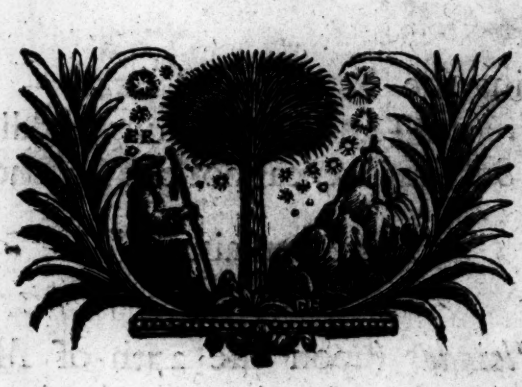
	H.	M.
The Time of the *Pleiades* coming to the South being	13	27
From which ſubſtract the Semidiurnal Ark ---- ———	8	16
There remains —— ——	5	11

So that upon the 15th of *October* the *Pleiades* do riſe at 11 min. after 5 at night.

From hence you may conclude, that if (upon the 15th of *October*) you ſhould ſee the 7 Stars riſing in the Eaſt, you may then conclude it to be 11 min. paſt 5 at night; and if you ſhould ſee them (in the Eaſt) one hour high, you may then conclude it 11 min. after 6, *&c.*

And thus may you readily and very exactly find the Hour of the Night by the Stars. And with theſe two Tables, and ſome of their Uſes, (for they are ſerviceable to other good Purpoſes) I ſhall conclude this *Eighth Book.*

The End of the Eighth Book.



THE

Upon the 15*th of* October.

	H.	M.
The Time of the *Pleiades* coming to the South was --	13	27
To which add the Semidiurnal Ark - - - - - - --	8	16
The Sum is - - - - - --	21	43
From which ſubſtract - - - - - - - -	12	00
There remains - - - - --	9	43

So that the *Pleiades* do ſet at 43 min. paſt 9 of the Clock the next Morning.

Likewiſe,

	H.	M.
The Time of the *Pleiades* coming to the South being	13	27
From which ſubſtract the Semidiurnal Ark ---- ———	8	16
There remains —— ——	5	11

So that upon the 15th of *October* the *Pleiades* do riſe at 11 min. after 5 at night.

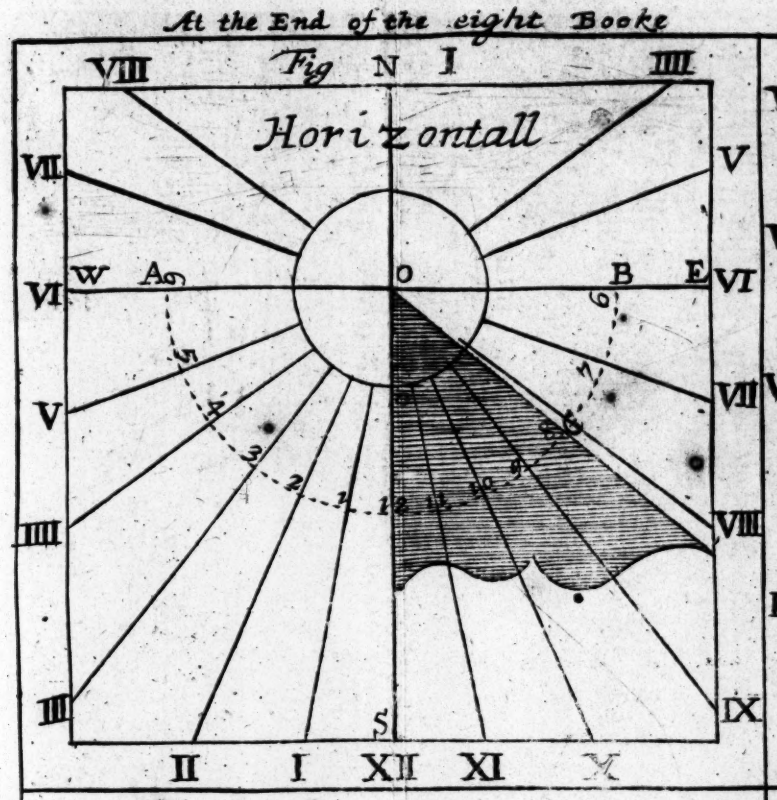
From hence you may conclude, that if (upon the 15th of *October*) you ſhould ſee the 7 Stars riſing in the Eaſt, you may then conclude it to be 11 min. paſt 5 at night; and if you ſhould ſee them (in the Eaſt) one hour high, you may then conclude it 11 min. after 6, *&c.*

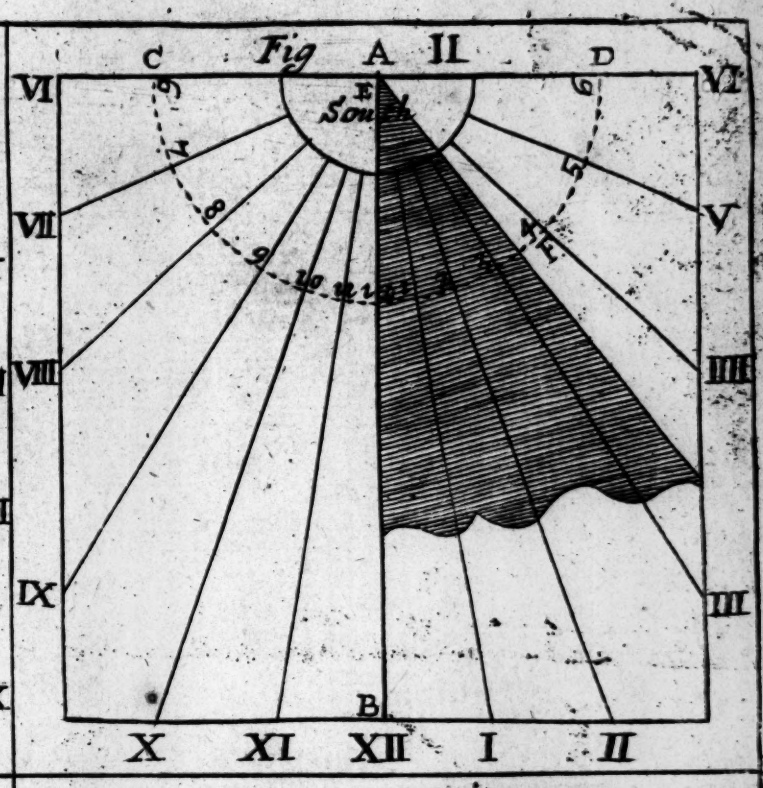
And thus may you readily and very exactly find the Hour of the Night by the Stars. And with theſe two Tables, and ſome of their Uſes, (for they are ſerviceable to other good Purpoſes) I ſhall conclude this *Eighth Book.*

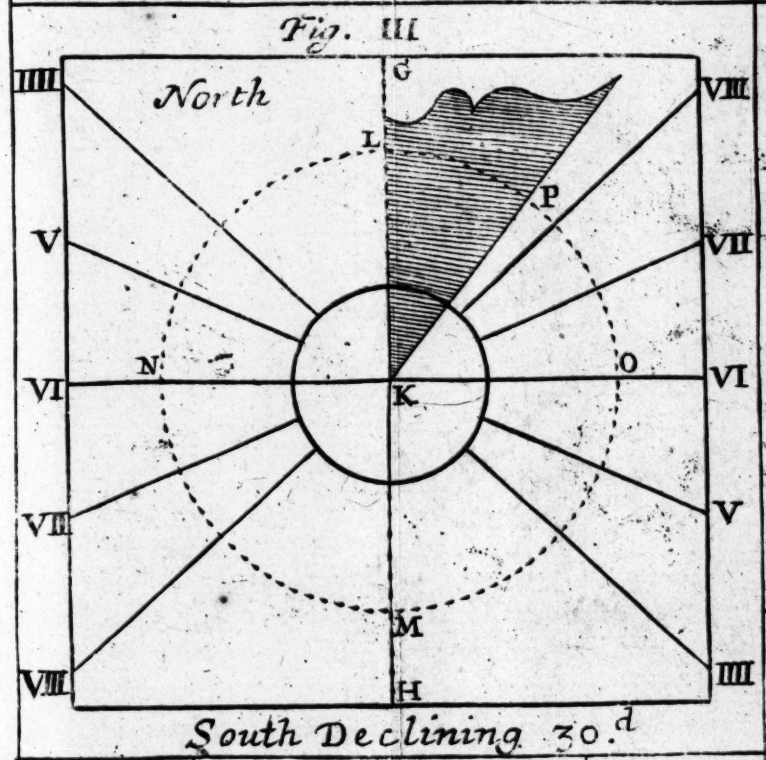
The End of the Eighth Book.

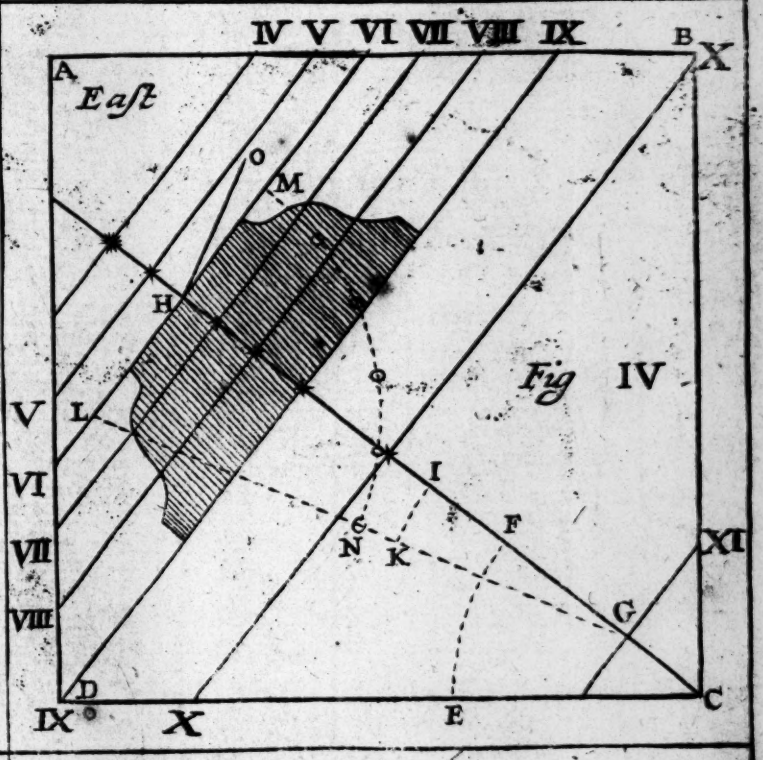
THE

At the End of the eight Booke









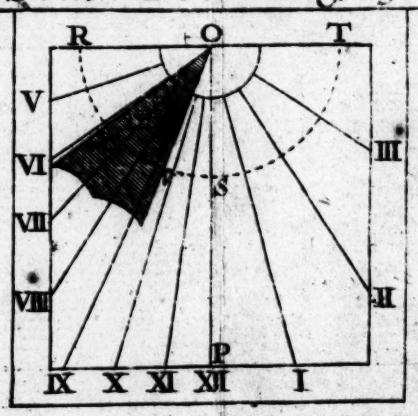


Fig. V

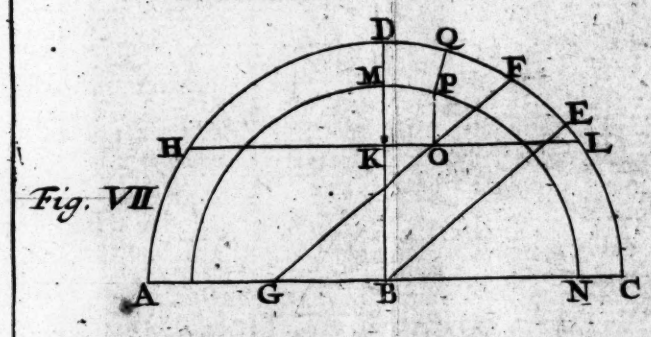


Fig. VII

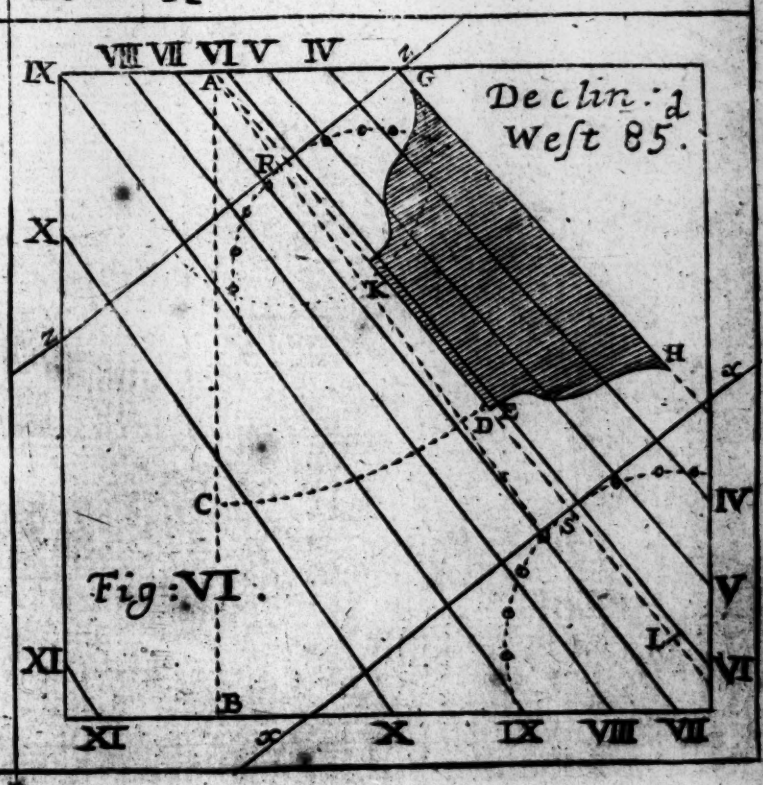


Fig: VI.

THE LEGAL PART OF SURVEYING.

The Ninth BOOK.

THE ARGUMENT.

THE other *Eight Books* conſiſting principally in *Mathematical Demonſtrations*, it may ſeem ſomething ſtrange to the Reader, to find any thing after: for when Art, by Demonſtration, hath done its beſt, what can be imagined to remain for farther Dilucidation? This at firſt Sight and common View ſeems a plauſible Inference: but when upon ſecond Thoughts you make a nearer Inſpection, you will find that there is ſomething wanting to make that *Idea* compleat: * 'Tis true, the *Mathematicks* demonſtratively conclude upon the *Theſes* laid in their own

T Art;

* *Therefore (by the Aſſiſtance of a Perſon learned in the Law) this Ninth Book is added.*

Art; And ſuch are the firſt *Eight Books*, which indeed have very abſolute *Concluſions* Mathematically demonſtrated: But yet there is a *Unum Neceſſarium*, one other neceſſary Ingredient, without which, the whole cannot be compleat: and this is the higheſt *Refined Reaſon*, which we in a familiar Style term the LAW. And if *Lex*, as is commonly reputed, be derived *à legendo*, from chuſing, then we may define it thus: *Lex eſt ea Rationis pars quam Intellectus format in actum, ſpectans tam ab antè quàm ad poſt ad neceſſitatem rei, conſuetudinem loci, & aptitudinem perſonarum.* Now according to this Definition, it is in a manner impoſſible that the Intellect ſhould rightly act without the help of theſe Adjuncts; therefore to ſhew that we at leaſt endeavour to aim at Perfection in this Work, we have added this *Ninth Book*. 'Tis true, ſome imperfect *Specimen* there was before, which in it ſelf was, though but an *Eſſay*, yet gave a Glimpſe of future Intentions, which in this we now hope to make appear, and ſhew you how neceſſary the Knowledge of the *Law* is to every Art. For when *Land* is *meaſured*, (which many Ruſticks are able to do) yet the *Lord* is little the better, neither knowing his *Tenures*, nor having due *Entries*, whereby either himſelf or his Steward are able to hold *Courts*, or decide *Differences* among the Tenants; nay ſometimes not to ſet forth the *Extents* or *Bounds*, whether they belong to this or that Lord.

THE

THE LEGAL PART OF SURVEYING

WE will not trouble you with Definitions of the Word *Manner*, though we could ſhew you ſeveral Etimologies thereof, as either Learning or Fancy has dictated: but we lead you into the Matter at firſt.

What a Manner is.

A *Manner* then conſiſts of Lands, Wood, Meadow, Paſture and Arable, Meſſuages, Tenements, Services, and Hereditaments, Whereof part are Demeſnes, being ſuch as anciently, *& ultra memoriam*, the Lord has ever uſed, occupied and manured with the Manor-houſe: The reſt are either Free-holds, Farms, or cuſtomary or copyhold Tenements. And theſe have uſually divers Services, beſides Rents belonging thereto.

The Original of a Manner.

NOW the Beginning of theſe Mannors originally aroſe from the KING, who when he gave Lands to his Followers in ſuch quantity as exceeded the Proportion of a Man's manuring, and being not diſtinguiſhed into Parts or Qualities, he to whom ſuch Land was given to him and his Heirs for ever, enfeoffed divers others in ſmaller Parts thereof, as ſome in 20, others in 40, and ſome in 100 Acres, and ſome more, ſome leſs: and in conſideration thereof, each Feoffee was to do ſome Service to the Feoffor, others to pay him Rents, and the like, with Reſervation of ſome Parcel of the Lands to himſelf to manure for the Support of his Family.

And

And this Erection of *Mannors* we may attribute to the Time of the *Normans*, becauſe we find no ſuch among the *Saxons*, though the thing in Subſtance was the ſame: for what we call *Mannor* they called *Berry*, both ſignifying a Manſion-houſe or Dwelling-place. And we find ſeveral Remains of the *Saxon* Name in divers Counties of this Realm, eſpecially in *Hertfordſhire*. The Tenements are uſually called in Latin *Prædia*, in Engliſh *Granges* or *Farms*, which Word is derived from the *Saxon Feormian*, ſignifying to feed or yield Victual: for heretofore the Reſervations were more in Victuals than ready Money.

Things appertaining and appendant to a Mannor.

I. THere is alſo belonging to a Mannor a *Court Baron*, and to ſome of more Note, a *Court-Leet:* to which, and ſo conſequently to the Mannor, are uſually appertaining *Fines*, *Iſſues*, *Amerciaments*, *Heriots*, *Waifs*, *Eſtrays*, *Eſcheats*, *Reliefs*, and other Perquiſites and Profits of Court,

II. There are alſo, or have been heretofore appendant to a Mannor, *Wards*, *Marriages*, *Advowſons*, *Patronages*, *Preſentations of Parſonages*, *Vicarages*, *Chappels*, *Prebends*, &c.

III. Alſo *Common of Paſture*, *Moors*, *Marſhes*, *Free Warrens*, *Cuſtoms*, *Liberties*, *Franchiſes* and *Privileges*.

IV. Likewiſe *Rents*, *Suits of Court*, *Tenths*, and *Services* iſſuing or repriſed out of other *Mannors*.

But all theſe make not a *Mannor*, nor doth the want thereof deſtroy it. And indeed of ſuch Nature is a *Mannor*, that although a Man have ſufficient Lands to eſtabliſh Meſſuages and create Services, and ſhould divide the ſame into Demeſnes and Tenement-lands, infeoffing Tenants in Fee in ſome part, and granting to others by Copy of Court roll, and do all other things belonging to a *Mannor*; yet will not all this make a *Mannor*, becauſe it is requiſite to a *Mannor*, that all theſe things be of long continuance.

A Mannor cannot be erected at this Day.

NO Man at this Day can erect a *Mannor*, for there muſt be *Very Lord* and *Very Tenant* in Fee-ſimple, and that of ancient Continuance: for a Man may have Demeſnes to manure, and Tenants to do him Services, and that for a long time, and yet no *Mannor*. As if a Man that had Land did give part of this Land in former time to ſome other to do him Services, here are Demeſnes in the Donor, and Services and a Tenure in the Donees; yet becauſe there be not *Very Tenants* in Fee-ſimple it maketh no *Mannor*.

A Mannor deſcending in divers Co-heirs.

BUt if a *Mannor* deſcend to divers Partners and Co-heirs, either in Joyntenancy or in Common, and they ſue out a Writ of Partition, and divide the ſame, and every one hath Demeſnes and Services, in ſuch caſe each hath a ſeveral *Mannor*, and may keep ſeveral *Courts-Baron*. 26.*H.* 8. 4.

A Mannor may be deſtroyed.

THough a *Mannor* cannot be raiſed at this Day, but in the caſe above-mentioned, yet may it be diſmembred or deſtroyed both in Name and Nature, by eſcheating the Free-holds and Copy-holds: for if there be not two at the leaſt of either of theſe, then are there no Suitors, and without Suitors can be no Court, and conſequently no *Mannor*: yet it may be termed a *Seigniory*, which can keep no *Court-Baron* at all. 35 *H. Fitzh.* 3. *c.*

How two Mannors may be united.

A Man having two *Mannors* lying together, whereof one is decayed, and hath loſt the Power of keeping a *Court-Baron*; the Lord is willing to have the Tenants of both theſe *Mannors* to do their Suits and Services to the Court of the other *Mannor* that remains: this intended Union cannot extinguiſh their ſeveral Diſtinctions, for they remain two in Nature, though the Lord deſire to make them one in Name; and the remaining *Mannor* hath no Warrant to call the Tenants of the decayed one, but every Act done in one to puniſh an Offender in the other is traverſable. Yet if the Tenants will voluntarily ſubmit to ſuch an Innovation, and the ſame be continued without Contradiction, Time may perfect ſuch an Union. But if one *Mannor* do hold of another, and it eſcheat to the Lord, the eſcheated *Mannor* may be united, and of two diſtinct *Mannors* may become one in uſe, if the Lord pleaſe.

Of the Propriety which a Lord may claim in his Mannor.

WE now proceed to ſet forth the Propriety a Lord claims in his *Mannor*, and we may term it an *Evidential Right* or *Propriety*, which is made out by his Deeds, Charters and Evidences; or a *Poſſeſſory Right*, ariſing from Duration of Poſſeſſion: and this may be either perpetual, which we call either *Allodium* or *Feodium*; or determinable.

Allodium.

A *Llodium* or *Feodium* is an abſolute Property and perpetual Right in Poſſeſſion, without Dependance on any ſuperiour Lord;

and this is proper ſolely to the KING, *Jure Coronæ.* And from hence in the Time of King *Edward* the *Confeſſor*, all the Crown-Lands were called Ancient-demeſne. *Kitchin* 98. *Bro. tit. Demeſne.* And in *Dooms-day* Book ſtill in the *Exchequer*, they are recorded under the Title of *Terra Regis.*

But this is not the Fee we think of, which we ſhall divide into *Fee-ſimple* and *Fee-tail.*

Fee-Simple.

FEE-Simple is of all other Eſtates the moſt large and abſolute that can by our Laws be made or veſted in any Perſon, and is that which is granted to a Man and his Heirs for ever, without any farther or other Limitation of Uſe or Uſes. But if a Man purchaſe in *Fee-Simple* to him and his Aſſigns for ever, omitting the Word *Heirs*, he hath an Eſtate for Term of Life: Alſo if Lands be granted to any Man with a Woman in Frank-Marriage, then the Word *Aſſigns* implieth an Eſtate of Inheritance, without mentioning the Word *Heirs*: and ſo likewiſe to a Man and to his Blood. And here we muſt conſider who are ſaid and underſtood to be a Man's Heirs by the Courſe of the Common Law: as for Example.

Heirs, who.

SUppoſe *A. B.* dies ſeized of an Eſtate of Inheritance without Iſſue of his Body: neither his Brother nor Siſter of the half Blood, nor their Iſſue ſhall be the Heir, nor his Baſtard, nor his Father, Mother, Grandfather or Grandmother; for Inheritance may lineally or collaterally deſcend, but not lineally aſcend: but the Brother or Siſter of the Father *A. B.* (being a collateral Deſcent) ſhall be his Heir: And then they dying ſeized without Iſſue, the Father of *A. B.* ſhall have the Land as Heir unto his Uncle or Aunt, but not as Heir to him.

Daughters joynt Inheritors.

SO by the Law of *England* the eldeſt Son is to inherit, and he dying without Iſſue, the ſecond Son, and ſo the reſt; and if there be only Daughters, they ſhall joyntly inherit as Coparceners: but if no Iſſue, neither Son nor Daughter, then ſhall the eldeſt Brother be Heir; and for want of ſuch elder Brother, all the Siſters; and in default of them, the Uncle by the Father's ſide, if the Land came by the Father, or be of the Purchaſe of him ſo deceaſed. But if there be no Heir of the Father's ſide, the purchaſed Lands goes to thoſe of the Mother's ſide: But if none ſuch be, then the Lands eſcheat to the chief Lord of the Fee.

Fee-

Fee-Tail general.

FEE-*Tail*, *Feodum talliatum*, is two-fold; either general, or ſpecial. *Fee-tail general* is, when Lands or Tenements are granted to any Man and the Heirs of his Body begotten, without Limitation to what Woman. Wherefore if ſuch Tenant in Fee-tail general marries divers Wives, and hath Iſſue by them ſeverally, they ſhall all be capable to inherit thoſe Lands. But if mention be made from what Woman the Heirs ſhall come, as if a Gift be made to *A. B.* and to the Heirs of his Body lawfully begotten on the Body of *C* his Wife, this is an Eſtate in *Fee-tail ſpecial*, for by means of this Grant none ſhall inherit that are begotten of another Woman.

Fee-Tail ſpecial.

ALſo if Lands be granted to *H. I.* and *K.* his Wife, and to the the Heirs of their two Bodies lawfully begotten; here the Man and his Wife are Joynt-purchaſers: and this is alſo a *ſpecial Tail* both in him and her.

So if a Man grant Lands or Tenements to another Man with his Daughter in Frank-marriage, this alſo is a *ſpecial Tail*,

So if Land be granted to a Man and the Heirs Males of his Body, this is an *Eſtate Tail:* and here the Females ſhall not inherit.

Of determinable Rights.

DEterminable Rights are fourfold; *viz.* 1. Eſtates after poſſibility of Iſſue extinct. 2. by Curteſy. 3. in Dower. 4. for term of Life or for Years, as by Leaſe, Mortgage, *&c.*

Tenancy after Poſſibility.

1. AFter *Poſſibility of Iſſue extinct* is this: If Lands or Tenements be granted to a Man and his Wife, and to the Heirs of their two Bodies lawfully begotten, and either of them die without ſuch Iſſue between them, then is he or ſhe ſurviving Tenant in Tail of thoſe Lands, but without Hope, and paſt Poſſibility of having ſuch Heir as was limited to inherit thoſe Lands; and therefore ſuch Survivor is called *Tenant in Tail after Poſſibility of Iſſue extinct*: and after the Death of ſuch Survivor, the Eſtate Tail ſhall be utterly void, and the Eſtate of Inheritance of, in and to thoſe Lands ſhall revert to the firſt Donor and his Heirs.

By Curteſy.

2. BY *Curteſy*: As if a Man marry a Wife being an Inheritrix, and hath Iſſue by her, and ſhe dye; he ſhall enjoy ſuch Lands as his Wife died ſeized of either in Fee-ſimple or Fee tail during his Natural life; and he is called *Tenant per le curteſy d'Angleterre*

terre, Tenant by the Curteſy of *England*, becauſe no other Nation admitteth ſuch an Eſtate. But in this Caſe the Law requires that ſuch Iſſue be born alive and heard to cry, although it dye immediately after: it is requiſite alſo that the Husband be in actual Poſſeſſion of thoſe Lands and ſeized of them *jure uxoris* at the time of her Death. But ſuch Tenant by Curteſy may not commit Waſt, for he is puniſhable for it by an Action of Waſt.

In Dower.

3. IN *Dower*: as for Example; By the Law of *England*, if a Man marry a Wife, and at any time during the Coverture he be lawfully ſeized either by Purchaſe or Deſcent of any Lands or Tenements either in Fee-ſimple or Fee-tail, and being ſo ſeized die, his Wife ſhall be endowed of a full third part of all thoſe Lands and Tenements during her Life, and is called a *Tenant in Dower*, this is *by the Common-Law*.

Dower in Cuſtome.

THere is a Dower *by Cuſtom*; for in ſome Places the Woman ſhall have a Moyety, and in ſome more, and in other Places leſs of her Husbands after Death: but this is according to the ſeveral Cuſtoms of the ſeveral Places.

But if the Wife be not above the Age of nine Years at her Husbands Death, by the Common Law ſhe ſhall not be endowed.

There are beſides theſe other kinds of Dowers, *viz.* one *ex aſſenſu Patris*, by the Fathers aſſent; another termed *Dos ad oſtium Eccleſiæ*; and a third *de la plus belle part*: As may be ſeen at large in our Books.

And though the Common Law be thus careful, yet for divers Cauſes a Woman may be defeated of her Dower: as, if ſhe or her Husband commit Treaſon, Murther or Felony, and be thereof attainted, (though afterwards pardoned:) ſo if ſhe forſake her Husband and live unchaſtly, and be not reconciled again without Compulſion of Law: or if ſhe detain and with-hold the Deeds and Evidences from the Heir of thoſe Lands wherein ſhe claimeth Dower, and the like.

There are alſo ſeveral things whereof a Woman cannot be endowed, as of Commons, Annuities, Eſtovers *ſans number*, Homages, Services, and the like.

Tenant for Life.

4. FOR *Term of Life*. Now a Tenant for Term of Life, is one who holdeth Lands or Tenements either for Term of his own Life, and then he is termed barely *Tenant pro termino vitæ*, Tenant for Life; or elſe for term of another Man's Life, and then is called *Tenant pur terme d' auter vie*, that is Tenant for term of another Man's Life. And if either of theſe commit or ſuffer Waſt, the

Leſſor

Leſſor or Reverſioner may have his Action of Waſt againſt him, and thereby recover treble Damages.

By Copy.

5. BY *Copy of Court-Roll.* Theſe in divers Mannors hold Lands and Tenements to them and to their Heirs, ſome in the Nature of Fee-ſimple, others in Fee-tail, or for term of Life or Lives at the Will of the Lord, according to the Cuſtom of the Mannor: In ſome they hold by Copy for term of Years. And all theſe have no other Evidence to ſhew for their Lands, ſave only the Copies of the Rolls of their Lord's Court. And if any of theſe alien or ſell his Lands by Deed, he abſolutely forfeits the ſame into the Hands of the Lord. If therefore he intend to alien, he muſt come into the Lord's Court, and ſurrender the ſame into the Lord's Hands to the uſe of Purchaſors. But in many Mannors the Surrender may be made out of Court to any Copyhold-tenant in the preſence of two of the Homage to the uſe aforeſaid, who are to preſent unto the Steward at the next Court, where the Purchaſor ſhall be admitted. And if any of theſe cut Timber growing on his Lands, without licenſe of the Lord, (but only for the Repair of his Tenement) it is not only a Waſt, but an abſolute Forfeiture. And in moſt Mannors if any ſuch Tenant ſhall let out his Lands for a longer time than a Year, without the Lord's licenſe, it is likewiſe a Forfeiture. But in theſe, and many other Caſes we are to be guided by the Cuſtom of the Mannor of which ſuch Tenants hold. Thus having gone through Eſtates of Inheritance and Freeholds, we next come to Chattels.

Of Chattels.

CHattels are of two ſorts, real, and perſonal.

Chattels real.

CHattels *real* are threefold: 1. Term of Years; 2. Tenure at Will; 3. Wardſhip of Lands.

Tenant for Years.

1. TErm *of Years.* A Tenant for Term of Years is one to whom an Eſtate is granted of or in Lands for any number of Years agreed upon between the Lord and Tenant, which Term is always expreſſed in the Leaſe ſo granted, as we ſee every Day. On which Leaſe there is uſually reſerved ſome Rent payable either half yearly or quarterly: For the Recovery and obtaining of which Rent being arrear, the Lord may either diſtrain, or bring his Action at Common Law. And upon theſe Leaſes there needs no Livery of Seiſin, as in Leaſes for Term of Life or Lives there muſt be. Nor may ſuch Tenant commit Waſt. And if he grant unto any other a larger Eſtate of what he holds than he himſelf hath therein, he ſhall forfeit his Leaſe.

At Will.

2. *Tenant at Will* is one to whom Lands and Tenements are granted to hold at the Will of the Leſſor: and this Tenant may be ejected or put out at any time, yea although he hath tilled and ſown his own Lands. Yet in this Caſe the Law allows him liberty of Ingreſs, Egreſs and Regreſs, as well to take, cut and carry away his Corn when it is ripe, as to take and carry away his Goods and Houſhold-ſtuff within convenient time, without committing Treſpaſs or otherwiſe. But the Leſſor hath the ſame Remedy againſt this Tenant as againſt Tenant for term of Years, for Recovery of his Rent that may or ſhall be in arrear or unpay'd: But this Tenant is not chargeable with Reparations,

3. *Wardſhip of Lands*, But this is abſolutely taken away by a Statute made in the twelfth Year of KING *CHARLES* the Second, Chap. 24. intituled *An Act*, &c.

Of the ſeveral Tenures in a Munnor.

THE next to be legally obſerved in a *Survey*, are the ſeveral *Tenures* that are, or may be found within the Mannor: as *Knights Service*, including Homage, Fealty and Eſcuage, and formerly drew unto it Ward, Marriage and Relief: but theſe three laſt are taken away by the before-mentioned Statute, 12 *Car.* 2. *cap.* 24. *Caſtlegard* alſo is within this Tenure, and alſo *Grand Sergeanty*.

Petit Sergeanty.

THen follows *Petit Sergeanty*, which in effect is no other than Socage, becauſe the Tenant is not bound to the Performance of any Perſonal Service, but to pay ſomething yearly. Then *Socage*, where a Man holds Lands or Tenements by Fealty and certain Rent for all manner of Services: and it was called *Servicium Socæ*, becauſe in ancient time theſe Tenants were obliged certain Days in the Year to plough and ſow their Lords Demeſnes: and the French Word ſo ſignifying, *Vomer*, a Coulter or Plough-ſhare, ſeems to imply ſo much. But now that Service is by mutual Conſent between the Lord and Tenant in many Places changed into an annual Rent, yet the name of Socage ſtill remains.

Burgage.

THE next Tenure is *Burgage*, where an ancient Borough holds of the KING by a certain yearly Rent. And theſe have divers Cuſtoms and Uſages peculiar to themſelves, and diſtinct from other Places, and ſometimes very different from the Common Law; but their Probability and Coherence with Reaſon together with a long Preſcription make them allowable, and therefore particular reſpect muſt be had to them,

Of

Of Copyhold-Tenure.

THere is alſo *Copyhold-Tenure*, which (ſaith *Kitchin* 80.) is a baſe Tenure, and was originally called *Villenage*. Fitz. 12. But this may now be properly termed *Meer-copy-hold*, and eſcheats forthwith to the Lord by Felony. *Kitchin* 81. And ſome is of more Eminence, and held by Verge (*Per Virgam*) in ancient Demeſne, according to the Cuſtom of the Mannor, being in effect a kind of Free-hold, (though reputed Copy) and yields to the KING *Annum, diem & vaſtum* upon Felony.

Fine at the Will of the Lord, Fine certain.

SOme of theſe Copy-holds make Fine at the Will of the Lord; others are held by Fine certain. And this is a kind of Cuſtomary Inheritance.

Tenants by Court-Roll.

BUt there is a kind of Cuſtomary Land belonging to the ancient Dutchy of *Cornwal*, and ſome few other Places, where the Tenants have no Tranſcripts of the Entries of their Admittances: and theſe Tenants may not improperly be called *Tenants by Court-Roll*. But where they have ſuch Tranſcripts, they are called *Tenants by Copy of Court-Roll*. In the firſt of theſe the Land was among the *Saxons* called *Folk-land*, and the latter *Bock-land*. Kitch. 86. 89.

Of Tenure in Fee-Farm.

THere is alſo a Tenure in *Fee-farm*; and that is a Fee, and imports a Perpetuity to the Inveſtee and his Heirs for an annual Rent of the third part, or the fourth part of the Value.

Of Rents, and their ſeveral Natures.

WE will not inſiſt any farther on this Point, but proceed to what follows neceſſarily, *viz.* Rents and their ſeveral Natures. Now theſe Rents are either proper, or improper.

Rents Proper.

RE*nts Proper* are three: *viz*, *Rent Service*, *Rent Charge*, and *Rent Stock*.

Rent Service:

RE*nt Service* is where a Man holds his Lands of his Lord by Fealty and certain Rent; or by Fealty, Service and certain Rent. *Lit. lib. 2. c.* 12. or that which a Man, making a Leaſe to another for term of Years, reſerveth yearly to be pay'd for them.

Rent

Rent Charge.

Rent Charge is where a Man makes over his Eſtate to another by Deed indented, either in *Fee*, *Fee-tail*, or for *Life*, yet reſerves to himſelf by the ſame Indenture a Sum of Money yearly to be pay'd to him, with Clauſe of Diſtreſs for Non-payment. See *Littleton ubi ſupra.*

Rent Secke.

Rent Secke, or *dry Rent*, *Redditus ſiccus*, is that which a Man, making over his Eſtate by Deed indented, reſerveth yearly to be pay'd to him, without Clauſe of Diſtreſs mentioned in the Indenture.

Rents improper.

Rents improper are, where of an uncertain and caſual Commodity a certain Rent or Receit is by Contract created and raiſed: as for *Licences*, *Swan-marks*, *Profits of Fairs*, *Markets*, *Courts*, *Cuſtoms*, *Tollage*, *Pontage*, *Cranage*, &c.

Of Perquiſites or Parallels to Profits belonging to a Mannor.

OTher Revenues belonging to a Mannor, and neceſſarily to be taken notice of in a Survey, are either Perquiſites, or Parallels to Profits.

Increaſe.

Perquiſites come either by Increaſe, or Caſualty. *Increaſe* comprehends all Profits derived from the Production of the Earth.

Caſualty.

BY *Caſualties* are intended all Duties and Services that be Appurtenant or Appendant to a *Mannor.*

Appurtenances.

UNder *Appurtenances* may be ranged, all *Royalties*, *Prerogatives*, *Juriſdictions*, *Franchiſes*, *Priviledges*, *Liberties*, *Services*, *Cuſtoms*, *&c.* and all Advantages derivable from them, as *Perquiſites of Courts*, and therein *Pleas*, *Fines*, *Amerciaments*, *Heriots*, *Waifs*, *Eſtrays*, *Deodands*, *Goods of Felons* and *Fugitives*, (by ſpecial Grant) *Forfeitures*, *Eſcheats*, *Treaſure trove*, *Warrens*, *Commons of Paſture*, *Turbary*, *Piſcary*, &c.

Appendants

Appendants.

Appendant are *Hoſpitals*, *Patronages* of *Churches* and Benefices, whoſe value is to be accounted from the Privilege of electing and preſenting an able Clerk to ſupply the Church, not from a Simoniacal Advantage raiſed from any Contract with another for Preſentation, *&c.*

Parallels to Profits.

Parallels to Profits are *Purſuits* of wild *Game*, which is held equivalent to profitable Accrewments, ſuch are *Hunting*, *Hawking*, *Fiſhing* and *Fowling*.

Hunting.

FOR *Hunting*, record what Beaſts of the Foreſt there be, and how frequent, and what of the Chace.

Hawking.

FOR *Hawking* enumerate the Fowls of Warren, as Pheaſant, Partridge, *&c.* and to this may *Fowling* be reduced.

Fiſhing:

Fiſhing is either in freſh Waters, as *Rivers*, *Brooks*, *Pools*, *Ponds*, *Lakes*, *Meers*, or *Ditches*; or elſe in *Seas* or other ſalt Waters. It is neceſſary therefore that all thoſe Fiſhings be taken notice of.

Of Repriſes, Deductions, Payments, Charges, and Duties, iſſuing out of the Mannor.

AS we have formerly underſtood that ſeveral Rents, Profits, and Commodities may yearly ariſe or grow out of any *Mannor* to the Lord thereof; ſo is it as fitting to conſider what Repriſes, Deductions, Payments, Charges and Duties may be yearly iſſuing or going out of any Mannor: for otherwiſe in the Concluſion of our *Survey*, or in making perfect Conſtats or particulars, (ſuch Duties not being repriſed) the true Value of the Mannor may oftentimes ſeem greater than in Truth it is.

Theſe *Repriſes* and *Deductions* are never certain or generally alike in all *Mannors*. They are Impoſitions and Duties whereunto the plot or Fee is in peculiar liable; and are any manner of Rents, either in Money, Capons, Hens, Pepper, Cummin ſeed, or the like, iſſuing and pay'd out of one *Mannor* to another.

Alſo *Suits of Court*, or annual *Fines* for the ſame, and the like, may be iſſuing and payable to a Sheriff's *Torn* or *Hundred*: alſo *Penſions* or *Portions* to *Eccleſiaſtical Livings*. Likewiſe a *Rent* may be iſſuing for a Way-leave or ſome particulat paſſage; alſo for *Water-Courſes*, or placing of *Pipes* for Conveyance of Water. Likewiſe yearly Fees to Officers, as *Stewards*, *Receivers*, *Bailiffs*, *Collectors*, &c. and alſo *Stipends*, *Salaries*, *Annuities* to *Chaplains*, *Lawyers*, or the like. All which are to be deducted, and the Eſtimation of Repriſes to be oppoſed to the total Valuation; by which means the *Remanet* is rectified, and the true Value retrieved.

Obſervations and Courſes to be held and taken for the orderly marſhalling of Surveys.

HAving thus far informed you of *The Legal Part of Survey*, by having ſhewn what a *Mannor* is, and the ſeveral Parts thereof, and likewiſe of all *Eſtates* in general, and what *Tenures*, *Services* and *Rents* are thereunto incident, appertaining and belonging: we will now proceed to the Obſervations and Courſes to be held and taken for the orderly marſhalling of Surveys, for accommodating Field-Entries in rough Books, for Ingroſſments and their Exemplifications, with framing of Terrars, Rentals, Cuſtom and Court-Rolls, Particulars, *&c.*

For the effecting of this, the Surveyor is to conſider for whom he is to undertake his Survey, whether for the King, or a Lord of a Mannor.

If it be to the King, then Commiſſion is to be obtained out of ſuch of his Majeſties Courts as relate to the Lands of the Surveyed, as out of the *Exchequer*, *Dutchy*, &c. Unto which Commiſſion Articles are to be annexed, which Articles ought to (ſee that they) be as ſtrong and efficacious as may be, for that he knows not what obſtinate perſons he may meet with in his perambulation.

But if the Survey be undertaken for a private Perſon, Lord of a Mannor, then (the Surveyor of himſelf not having power to adminiſter an Oath) the Steward of the *Mannor* is to be joyned with the Surveyor. Or otherwiſe, The Surveyor is to have a Commiſſion granted from the Lord of the *Mannor*, under his Hand and Seal, to perform the Office both of Steward and Surveyor of his *Mannors*, *Lands*, and *Tenements*, for a certain time, during his pleaſure. And then may the Surveyor of himſelf execute the Offices and Duties both of Steward and Surveyor.

The Form of a Deputation or Commiſſion granted from a Lord of a Mannor to a Surveyor, may be in this or the like Form.

Omnibus ad quos hoc præſens ſcriptum pervenerit A. B. *de* C. *Comit'* E. *Armig' ſalutem. Sciatis me præfat'* W. L. *tam pro ſincero amore & benevolentia qua jamdudum affectus ſum erga* A. R. *de cujus provida circumſpectione, pia ſedulitate, ac ſingulari in hac parte prudentia merito plurimum confido, quam pro diverſis aliis cauſis & conſiderationibus, ex mera & ſpontanea voluntate me dediſſe & per præſentes conceſſiſſe eidem* A. R. *Officium Seneſchall' ſive Seneſchalciam omnium & ſingulorum Domin', Maner', & Hæreditament' meorum quorumcunque in Comit'* F. *& cuſtod' ſive Officium tenendi omnes & omnimodas Cur' Baron' Letar' viſ' Franc' pleg' Dominor' & Maner' prædict' & eorum cujuſlibet, ac gubernationem & ſupervifionem eorundem, ac Ipſum* W. L. *Generalem ac Capital Seneſchal' ac ſuperviſorem meum omnium Curiarum, Dominorum, Maneriorum & Hæreditamentorum meorum prædict' facio, conſtituo & ordino per præſentes, Habend' tenend' gaudend' exercend' & occupand' Officia prædict' cum pertinentiis, à dat' præſentium durante beneplacito meo. Mando inſuper univerſis & ſingulis Balivis, præpoſit' firmariis, tenentibus & occupatoribus meis præmiſſor' & eorum cuilibet, quod præfat'* A. R. *de tempore in tempus, aſſiſtentes ſint, obedientes, & auxiliantes in omnibus prout decet durant' termin' prædict. In cujus rei teſtimonium huic præſenti Scripto meo Sigillum meum appoſui.* Dat'.

Or to the ſame purpoſe in Engliſh.

TO all Perſons to whom this preſent Writing ſhall come, I A. B. *of* ------ *in the County of* C. *Knight and Baronet; ſend Greeting. It is my Will and Pleaſure, That* W. L. &c.

This is an uſual Form, but commonly Lords of *Mannors* do direct their own Letters of Warrant to their Tenants, unleſs the Surveyor be a known Surveyor by Patent, for the holding a Court-Baron; which being performed, and the Charge of the ſaid Court ended, the Surveyor may proceed in this manner:

Firſt, Taking notice of the Names of every Tenant, both Freeholder and Copy holder, Leſſee and Tenant at Will in a Paper, and a Jury for the Survey being impannell'd (after they be ſworn) the Surveyor may give them a Charge in Words according to his own Diſcretion relating to all the Particularities we have herein before mentioned, and ſuch others as ſuit with the Exigence of the ſaid Mannor.

Then he is to receive from the Bailiff all ſuch Rentalls as he hath as well ancient as later, which you are diligently to compare together, noting the Difference: and if the latter be leſs, then what

De-

Decays of Rent there are, and how occaſioned; if greater, then what encreaſe of Rent, and how raiſed: which muſt be carefully expreſſed when the Roll comes to be engroſſed.

Next let the Rental be reduced to an Alphabetical Form wherein write the preſent Tenants Name and the Name of his Predeceſſor, which will be a great Help for the ſpeedy Diſpatch of the Entries, and the more eaſie and ready finding any Tenants Name or Rent; in this manner.

	lb.	*s.*	*d.*
Anderton Thomas, late *Chapmans*, Rent *per Annum* ——	01	10	00
Barnadiſton George, late *King*, Rent *per An.* ——	02	00	00
Cadman William, late *Fiſher*, Rent *per An.* ——	00	10	00
Dodſon George, late *Smart*, Rent *per An.* —— ——	00	13	04

It is alſo to be conſidered, that moſt *Mannors* conſiſting of divers Townſhips or particular parts, and the Tenancy of thoſe Townſhips of divers Eſtates, as aforeſaid, therefore it is fitting that not only every of thoſe Townſhips but the ſeveral Eſtates therein, be entred and taken ſeverally and particularly by themſelves, that is all of one and the ſame Townſhip and Eſtate under one and the ſame Title, for avoiding Confuſion. And theſe Entries ought to be made in looſe Sheets of Paper at large, keeping them always ſorted according to the ſeveral Townſhips and Eſtates, till they be all finiſht; and then to be filed together orderly in a Book. When this is prepared and the Inſtrumental Menſuration finiſhed, and the ſeveral Contents thereof caſt up, then make an Alphabetical Table of all the Tenants Names; with the Name of the Lord alſo for Demeſnes, and of the Parſon for the Glebe; and ſo accordingly perfect your Entries from your Field Books and rough Books of Entries. And when this is done for the true and certain Quantities according to Meaſure, then proceed to the Valuation.

Now the beſt, ſpeedieſt, and moſt certain means to accompliſh this may be this: Firſt, Let it be conſidered that all Grounds generally as to quality conſiſt of theſe three kinds; 1. Meadow; 2. Arable; 3. Paſture. And ſuppoſing every of theſe kinds likewiſe to conſiſt of 3 ſorts as to Value and Goodneſs, as, the 1ſt and beſt ſort, the ſecond and mean, the third and worſt: Therefore at the time of the Inſtrumental Menſuration let it be conſidered, and noted in your Field-Book which of thoſe three ſorts any Field or Cloſe conſiſteth of. And having informed your ſelf of the general Value, what the beſt ſort of Meadow, Arable, and Paſture is worth by the Acre, and the like of the other ſorts throughout the whole *Mannor*; then according to thoſe Rates enter every particular parcel by it ſelf; yet before theſe Entries are to be engroſſed, it is to be enquired and conſidered what other profits and Commodities, beſides theſe Lands and Tenements, are demiſed and granted by the Lord to any Tenant within the *Mannor* for yearly Rent or otherwiſe, which likewiſe are to be entred with the Rents and Yearly Values thereof, as Mines of Tin, Lead, Copper, Coal, *&c.* Quarries of Stone, Fiſhing, Fowling, Hawking, Hunting,

Hunting, Juſtments, Herbage and Pannage, free Warrens, cuſtomary Works or Services, Profits of Fairs and Markets, and Moſſes of Peat and Turf; all, or any of which, and the like, may be within a *Mannor*, and diſpoſed and let out for annual Rents, and are in no wiſe to be omitted. All which Premiſſes, and the ſeveral quantities, Rents and Values thereof, are to be ſummed up, and their ſeveral Totals to be expreſſed.

Then muſt be ſet forth the ſeveral Repriſes iſſuing out of the ſame *Mannor*, being ſuch as we have before mentioned. All which being likewiſe ſummed up, the Total thereof is, as we ſaid, to be deducted from the former Value, and the clear Remainder is to be ſet down.

The next thing to be conſidered is, if any of thoſe Profits or Commodities laſt before named, or the like, are within the *Mannor*, and not by Leaſe or otherwiſe for any certain yearly Rent: and if any ſuch be, they are to be mentioned as Caſualties, and the yearly Value thereof eſtimated, what they may or are likely to prove worth by the Year. Alſo the Names and Quantities of the common Fields, common Meadows, ſtinted Paſtures, and all other unſtinted Commons, how they are accuſtomed, held and occupied; whether peculiar to the Lords and Tenants of that Mannor, or whether any other Lord or Lords and their Tenants have rake, eſcape, eatage, or other Intereſt therein, and the Butts, Bounds and Limits thereof ſeverally. Alſo what Woods and Under-woods are within the Mannor, and their ſeveral Values. Then would there be entred an Abſtract in nature of a Cuſtom-roll, ſhewing briefly all the Cuſtoms anciently of or belonging to the Mannor: and alſo a Suit-roll of all the free Suitors, *&c.* and laſtly, a true and perfect Deſcription of all the Out-bounds and Limits of the whole Mannor.

For other the Lord's poſſeſſions compriſed or fit to be compriſed within the Survey, and reputed no part or Member of the Mannor, they require to be recorded apart in the *Infra* under the diſtinct Title of *Non-Parcels*, viz. Churches, Chappels, Alms-houſes, *&c.* Alſo Patronages, Villains, Commons, Annuities, and other particulars held in groſs. And now when all is done, Regiſter all Omiſſions under the ſeparate Title of *Memorandums*.

Of the Order of keeping a Court of Survey. And of the Charge to be given to the Jury, by the Steward of the Court: or by the Surveyor (if authoriſed thereunto)

HAving followed theſe Directions in your Entries and Books, it is now time to ſummon together your Tenants in order to the keeping of your Court of Survey, which is to be performed in this or the like manner.

The ſeveral Tenants of the Mannor being met together at the place appointed where the Court is to be kept, and the Style (or Title) of the Court entred: Then cauſe the Bayliff of the Court to make Proclamation by crying once *O Yes*; and afterwards will him to ſay after you, Thus:

ALL manner of Perſons, who were ſummoned to appear here this Day, to ſerve the Lord of the Mannor for his Court now holden, draw near and give your Attendance, and every one anſwer to his Name as he ſhall be called, upon the Pain and Peril that may fall thereon.

THen call (by the help of your Rental) all the Tenants ſeverally by their Names, marking ſuch as are abſent to be amerced.

This done, Cauſe the Bayliff of the Court to make another *O Yes*, willing the Tenants to draw near, keep Silence, and out of thoſe Tenants which are preſent, ſelect moſt of the ſufficienteſt and ableſt for your Jury, whoſe Names having from your Rental written in a paper by themſelves, call them by their Names accordingly. Which done, cauſe him that is the Foreman to lay his right Hand on the Book, and ſwear him in this or the like manner.

YOU ſhall diligently enquire and make true Preſentment of all ſuch Matters as on the Lord of this Mannors behalf ſhall be given you in Charge. You ſhall neither for Fear, Favour, or Affection, or other partial Reſpect whatſoever, forbear to preſent what you ought to find; or find what you ought not to preſent. You ſhall herein keep the Lords Counſel, your own and your Fellows, and in all things according to a ſincere and upright Conſcience you ſhall preſent the Truth, the whole Truth, and nothing but the Truth, as by Evidence and your own Knowledge you ſhall be induced, to the beſt of your Power, ſo help you God, &c. *cauſing him to kiſs the Book.*

When the Foreman is thus ſworn, cauſe three or four more of the Jury to lay their Right Hands on the Book, and give them their Oath as followeth:

THE ſame Oath which your Foreman before you hath made and taken, you and every of you, for your Parts, ſhall truly keep and perform to the utmoſt of your Power, ſo help you God, &c. *and let them ſeverally kiſs the Book.*

And in this manner ſwear all the reſt.

Which done, Cauſe the Bayliff of the Court to make a third *O Yes*, and ſay thus;

ALL you that be here ſworn, draw near, and hearken to your Charge, the reſt keep Silence.

The

The Charge to be given to the Jury, may be divided into these following Heads, *viz.*

1. You are to enquire whether *A. B.* be Lord of this Mannor of *C.* and if not, who hath the Right and Interest in or of the same to your Knowledg,

2. You must shew unto the Surveyor in his Perambulation all the Circuit, Butts, Bounds and Limits of the same, and upon what and whose Mannors, Lordships, Lands and Parishes it borders; and whether any confining Lord or his Tenants do any where incroach upon it, and by whom, where and how much is so incroached.

3. Whether there be any other Mannor or Mannors lying within the Limits or Circuit, or extending in part into this Mannor: what are their Names? and who are Owners of them? and how are they distinguished from this? and doth this lye within any other Mannor?

4. What Freeholders there are within, or belong unto, and hold their Land of this Mannor? what are their Names? what Land do they hold, and by what Tenure? what Rent do they pay? and what Services do they owe?

5. Whether any Freeholder within or belonging to the Mannor hath committed Felony or Treason, and hath been thereof convicted, the Lord not yet having the Benefit of the Forfeiture: or whether hath any such Tenant died without Heir general or special? If so, who hath the present Use and possession of the Land, and by what right? what is the Land? where lies it? and how much in Quantity, and of what Value?

6. Whether doth any Bastard hold any Land belonging to the Mannor as Heir to any? what is his Name? what Land is it? where does it lye? and what is it yearly worth? Here we are to observe that a Bastard, though he be known to be the Son of that Father that leaves him the Land, cannot inherit *jure hæreditatis* but by Conveyance. Neither if he purchase Land in his own Name, can any inherit it after him of his supposed Blood, unless he be married and have Children lawfully begotten, because it is *contra formam Ecclesiæ*, as appears by the *Stat. of Merton, cap.* 9. For a Bastard is no Man's or every Man's Son or Daughter; according to the old Verses,

Cui Pater est Populus, Pater est sibi nullus & omnis:
Cui Pater est Populus, non habet iste Patrem.

7. What Demesne-lands has the Lord within or belonging to the Mannor? what and how much Woods, Under-woods, Meadow, Pasture, Arable, Moors, Marishes, Heaths, Wasts or Sheep-walks? and what is every kind worth yearly by the Acre? how many Sheep may the Lord keep upon his Walk Winter and Summer? what is a Sheep-

Sheep-gate worth by the Year? and what is every Acre of Wood worth by the Year?

8. What Demeſne lands hath the Lord lying in the common Fields of the Mannor? how much in every Field and every Furlong? what is an Acre of ordinary Field arable Land worth by the Year? The like is to be ſaid of Demeſne-meadow lying in any common Meadow within the Mannor.

9. What are the Names of all your common Fields? and how many Furlongs are in every Field? what common Meadows and their Names? and what Beaſts or Sheep may every Tenant keep upon the ſame when the Corn and Hay is off? and what is a Beaſt-gate and Sheep-gate worth by the Year? at what time are your common Fields and Meadows laid open? how are they or ought they to be uſed? whether is it lawful for the Tenants to incloſe any part of their common Fields and Meadows without the Licenſe of the Lord and Conſent of the Tenants?

10. What Commons are there within the Lordſhip which do properly belong to the Lord and Tenants of the Mannor? and how are the Tenants ſtinted? whether by the Yard-land, Plough-land, Ox-gang, Acres, or Rent? how many may every Tenant keep after either Proportion or Rate? Here we are to take Notice of the Statute called *Extenta Manerii* made 3 *E.* 1. in which this kind of Paſture is called *Paſtura forinſeca*, forein Herbage or Paſture, becauſe no part of it is proper to any peculiar Tenant, no not to the Lord himſelf, as are the common Fields and common Meadows. This kind of Common or *Paſtura Forinſeca* is of three ſorts. The one is where a Mannor or Townſhip, holding their Land in ſeveralty, have by conſent limited a certain parcel of Ground to lie common among them, and from the beginning have ſtinted every Man according to a proportion between them agreed; and that is commonly by the Acre. 2. A ſecond manner of ſuch kind of common Paſture is where certain waſt Grounds, one, two or more lie within the Townſhip or Mannor, and the Herd of the whole Town is guided and kept by one appointed by the Tenants, and at their general Charge, to follow and look to their Cattle: in which kind of Paſture there is alſo a Limitation both of the Number and Kinds of Cattel. And this is uſual in the North Parts. 3. A third kind of this Paſture or common Feeding is in the Lord's own Woods that lie common to the Tenants, as alſo common Moors or Heaths that were never arable. In the two former there is a certian Stint and Allotment both to the Lord and his Tenants: but in this latter the Lord ought not to be limited, becauſe ſuppoſed his own, and the Tenants have no certain parcel thereof laid to their Holdings, but only bit of Mouth with their Cattel. But the Tenants ought to be ſtinted in all ſorts of Common. Now Commons may be diſtinguiſhed into, 1. Common in Groſs; 2. Common Appendant; 3. Common Appurtenant; and, 4. Common by way of Neighbourhood. 1. *Common in Groſs* is where a Man by Deed granteth unto another

another Common of Paſture, 2. *Common appendant* is where a Man is ſeized of Land to which he hath Common for ſuch Beaſts as ſerve for compoſting his Land, wherein Geeſe, Goats and Hogs are exempted: and this kind of Common is by Preſcription as an Appendix or Addition only to arable Land, and not to any other. 3. *Common Appurtenant* is in the ſame Quality, but with greater Liberty, becauſe it is for all kinds of Cattel, Hogs, Goats, *&c.* as well as other Cattel. And this Common may be made at this Day, and may be ſerved from the Land to which it is appurtenant, and ſo cannot Common appendant be. 4. *Common by way of Neighbourhood* is where the Tenants of two Lords or more adjoyning do intercommon either upon other with all commonable Cattel. But one may not put his Cattel upon others Commons otherwiſe; for if they do, an Action of Treſpaſs lies.

11. Whether hath any Man incroached upon any part of the Lord's Waſt by Incloſure, or adding any part thereof unto his own Land? who hath ſo done? where? how much, and how long hath it continued?

12. Whether hath the Lord any Park or Demeſne-wood, which by ſtocking, may turn to the Lord's better Benefit by Paſture, Arable or Meadow? and what is an Acre worth one with another, he ſtocking? how many Acres does the Wood contain? and what will an Acre of the Wood be worth? and what will the Land ſo ſtocked be worth an Acre?

13. What cuſtomary Tenants are there within or belonging to the *Mannor*? what are their Names? and what Meſſuages, Tenements, or Lands do they hold by Name? and what Rent do they pay? and what ariſes to the Lord by the Death of any ſuch Cuſtomary Tenant, or by the Death of any Free-holder, by Fine, Heriot or Relief by the Cuſtom of the *Mannor*?

14. How doth the cuſtomary Land of the *Mannor* by Cuſtom deſcend after the Death of an Anceſtor? and whether will the Cuſtom of the *Mannor* allow an Entail by Copy? and whether doth it bear Widows Eſtate? and whether may a Man be Tenant by the Courteſy.

15. Whether are there any Cuſtomary Tenements that are Heriotable diſmembred and divided into parcels to the weakning of the Tenement? and who be they that have theſe Heriotable parcels? and what quantity hath every one of them?

16. Whether are not the Fines for Admittance of a new Cuſtomary Tenant being Heir, or coming in by Purchaſe or upon Surrender, at the Will of the Lord? or are the Fines always certain?

17. How and by what means may a Cuſtomary Tenant forfeit his Copyhold-Tenement? and whether hath any ſuch Tenant offended in any ſuch manner? and who by Name? that is, have they felled any Timber-trees, ploughed up Ley-grounds or Meadows never tilled before, ſuffered their Houſes to decay, pulled down any Houſes, or committed any other wilful Waſt?

18. What are the Cuſtoms of the *Mannor* in general, both in the Lord's behalf to perform or ſuffer to the Benefit of his Tenants, and of the Tenants to perform to the Service of the Lord?

19. Whether is there within the *Mannor* any *Villain* or *Neife*, that is, any *Bond-man* or *Bond-woman*? if there be, what are their Names? what Land do they hold? and what is the ſame annually worth? and what Goods do they poſſeſs? Obſerve this Tenure is quite out of uſe.

20. Whether hath any Tenant or other Perſon within the *Mannor* ſtocked up any Hedge-row, ploughed up any Balk or Land-ſhare, removed any Mere-ſtone, Land-mark, or other Bounds between the Lord's Demeſne and the Tenant's Freehold or Cuſtomary Lands of Inheritance, or between his Freehold and Cuſtomary Land, or elſewhere? where is any ſuch Offence committed? by whom? and where ought the ſame to ſtand?

21. What Cuſtomary Cottages are there within the Lordſhip, Toſts, Croſts, or Curtelages? what are the Tenants Names? what Rent do they pay? and what Services do they owe?

22. Whether are there within the *Mannor* any new Tenements or Cottages, Barns, Walls, Sheds, Hovels, Hedges, Ditches, or ſuch like, erected or ſet up, or any Water-Courſes or Ponds digged upon any part of the Lord's Waſt, without the Lord's licenſe? where is it? and by whom was it done, and by whoſe licenſe, and upon what Conſideration?

23. What Tenants are there within the *Mannor* that hold any Lands or Tenements by Indenture of Leaſe? what are their Lands? what hold they, for what Rent, under what Conditions or Covenants, and for what Term of Years or Lives?

24. Whether hath or doth the Lord imploy any Land to *Juſtment*, as in taking in Cattel to Paſture and Herbage? who hath the diſpoſing of the ſame? what quantity of Land is ſo diſpoſed? and how many Cattel will it paſture? and what is a Cow, Ox, Horſe, or Sheep gate worth within the *Mannor*?

25. Whether hath the Lord of the *Mannor* any Cuſtomary Water-mill, Wind-mill, Horſe-mill, Grieſt-mill, Mault-mill, Walk-mill, or Fulling-mill? whether is there within the Mannor any other Mill, Iron-mill, Furnace, or Hammer, Paper-mill? Sawing-mill, Sheer-mill, or any other kind of Mill? what is it worth by the Year? and in whoſe Occupation is it? Here obſerve, that to the Cuſtomary Corn-mill doth belong the Duty from the Tenants, *viz.* that they are bound to grind their Corn at the Lord's Mill: and that kind of Cuſtom is called *Socome*. And this may be divided into two ſorts; *Bond-ſocome*, where the Tenant is bound by Cuſtom, as where his Corn grows upon the *Mannor*; and *Love-ſocome*, where he grindeth of free Will; as Corn bought in the Market, the Tenant is at liberty to grind it where he pleaſeth, yet out of kindneſs to his Lord brings it to his Mill.

26. Whether

26. Whether hath the Lord of the *Mannor* any particular Fiſhing within any River, Brook, Meer, Pond or other Water? where and how far doth it extend? and what is it yearly worth? and who be Farmers thereof? and what common Fiſhings are therein? and how are they uſed? concerning this Article ſee 25 *H.* 8. *cap.* 7. and 31 *H.* 8. *cap.* 2.

27. Whether hath the Lord any Fowling wirhin his *Mannor* by reaſon of any Moors, Mariſhes, Watets, Brooks, Reeds or ſuch like; or any Woods wherein do breed any Stork, Shovelers, *&c.* or any Pibble, Beach, or Sea-bank wherein any Fowl breed? who takes the Profit of them? and what may they be worth by the Year unto the Lord?

28. Whether hath not the Lord of the *Mannor ultra memoriam hominis*, had and received all Waifs, Eſtrays, Felons Goods, Treaſure trove, and ſuch like profits within the *Mannor*? and whether hath he been anſwered of them from time to time truly or not? and who is the Officer that overſees the ſame, and whether be they totally and fully anſwered?

29. Whether are there within the *Mannor* any Tin-Mines, Lead-Mines, Copper-Mines, Coal-Mines, Quarries of Stone, *viz* Marble, Free-ſtone, Mill-ſtones, Lime ſtones, Grind-ſtones, Marle or Chalk-pits, ſlimy or mooriſh Earth fit for ſoiling of Land, or any Potters Clay or Clay for Brick or Tile, or any Fullers Earth, or any Sand Gravel-pits, or ſuch kinds of Commodities? and what are every of them worth by the Year to the Lord? or how are they improvable?

30. Whether there are within the *Mannor* any Turfs, Pears, Heath, Broom, Furzes, *&c.* which are or may be ſold yearly within the *Mannor* to the Lord's profit? and what may they yield by the Year if improved to the utmoſt Value? Here note that theſe things before mentioned are not of equal Uſe and Advantage in every Country: for *Eſſex* affords little of them; but *Northumberland*, *Cumberland*, and *Weſtmorland*, as alſo *Lincolnſhire*, *Cambridgeſhire*, *Lancaſhire*, *Yorkſhire*, and many other places yield good ſtore of them, and they are there uſed as good Fuel.

31. Whether is there within the *Mannor* any Slate-ſtones for Tiling, red or black Lead or Oker for Marking-ſtones? Note that *Cornwall* abounds in Slate, and *Derbyſhire* hath plenty of the Marking-ſtones, and ſome Mill-ſtones.

32. What Deer hath the Lord in his Park? who is Keeper? and what is his annual Fee? hath he any Warren of Coneys or Hares? who is the Keeper of either of them? and what Fee hath he by the Year? what are the ſaid Park and Warren worth by the Year to be let by the Year, if the Deer, Coneys or Hares were deſtroyed? Note that a Park for Deer is more for the Pleaſure than for the Profit of the Lord or Commonwealth: Warrens of Coneys are not unneceſſary, as requiring no rich Grounds to feed in, but mean Paſture and craggy Grounds are fitteſt for them.

33. What

33. What Penſions, Portions, Payments or Fees are or ought to be yearly paid out of the *Mannor*? to whom ought they to be paid, and for what? and whether have they been duly paid, or diſcontinued, and how long? Theſe Things ought to be duly examined, as well as to what goes out of the *Mannor*, as what is received in.

34. Whether is there within this *Mannor* any Weekly Market, or any Fair at any time of the Year? on what Day or Days? who hath the Toll and Profits thereof? and what may they be worth, either in his own Hands, or to let to Farm? Here note, that Markets and Fairs are not appendant to a Mannor, but commonly held by Patent from the KING.

35. Whether hath the Lord any Leet or Law-Day within the *Mannor*? what is the Extent thereof? and whether is there any Court kept within the *Mannor* from three Weeks to three Weeks? and of what hath the ſaid Court power to judge and determine.

36. Do you know of any that have any Deeds, Evidences, Court-Rolls, Rentals, Suit-Rolls, Cuſtom-Rolls, Books of Survey or Account, or any other Eſcripts or Muniments touching or concerning this *Mannor*? if you do, you are to produce them, or cauſe them to be produced.

37. Who hath the Advouſon, Nomination, Preſentation and Gift of the Parſonage, Vicarage, or Free-chapel belonging to this *Mannor*? whether the ſame is an Impropriation? and who is Incumbent of the ſaid Parſonage or Vicarage? or who hath the Impropriation in uſe? and what is it worth by the Year? This, though it ought to be inquired, yet I ſuppoſe is not to be reckoned as parcel of a *Mannor*, becauſe a Matter of Spiritual or Eccleſiaſtical Function cannot be parcel of a ſecular Living: But a *Mannor* as touching the Tithe may belong to an Eccleſiaſtical Charge. Nor do I conceive an Impropriation, though it belong to the Lord, to be parcel of the *Mannor*; becauſe from the firſt Inſtitution it was ſeparated to a Spiritual Office: and though the profits were afterwards diſpoſed to a Secular perſon, yet do they thereby become parcel of the *Mannor*.

38. Whether is there any Land concealed or Rent detained within this *Mannor*, and by whom, for what, how much, how long? or whether is any Land granted in Mortmain?

39. Who is the Lord's Bailiff? what is his Name? hath he a yearly Fee? and doth he hold by Patent for Life, or at the Will of the Lord? who is Steward of the Lord's Courts? what is his Fee? and how doth he hold? who is Woodward? and what other Officers are there within or belonging to this *Mannor*? and what are their Fees or Salaries? Here note, that ſundry *Mannors* have divers Officers, ſome appointed by the Lord, and ſome by the Tenants: But theſe are ſo known, that they need not be particularized.

40. Within what Dioceſe and Deanery, or within what Diviſion and Hundred lies this *Mannor*? what Beacons are you appointed to watch and ward at? and where are you generally called to Muſter

and

and ſhew your Armour? Here obſerve that the Eccleſiaſtical Juriſdiction takes place in all Counties, for the Ordinary is precluded in his Viſitation. Every Subject is to anſwer for himſelf according to his Family and the Extent of Family or Lordſhip, The Ordinary may inquire concerning Recuſancy, and the Miniſterial and Civil Officers into Bounds and Limits. How neceſſary Beacons have been in the times of common Invaſion, is obvious to every Eye that has lookt into our Hiſtories: and for Muſters, though there were anciently a certain place, yet by late Statutes ſince his *MAJESTY*'s happy *Reſtauration*, the *Militia* is otherwiſe ſettled, and all perſons may be called to Muſter and ſhew their Arms, where the Lords-Lieutenants, or the Deputy Lieutenants ſhall ſummon them to appear within the County, and in caſe of Invaſion they may be ſent farther.

41. What Market-towns are neareſt unto this *Manner*? and what Commodities are there ſpecially vented? This is very neceſſary to be known by the Lords, eſpecially ſuch as live far diſtant from their *Mannors*, becauſe many times they may fit themſelves with Tenants fit and capable to ſupply thoſe Neceſſaries, which haply otherwiſe might be wanting.

Theſe are the principal Articles that every *Surveyor* ought to inquire into; but he may in his Diſcretion order his Buſineſs ſo as not to be tied to this particular Form of Words, yet he muſt take the Subſtance of theſe Articles, or ſuch or ſo many of them as he conceives (guided by ſome Preinſtruction or fore Knowledge of the State of the *Mannor*) are fitteſt to be delivered to the Jury: and withal he is to explain to them the Meaning of every Article more at large, as in ſeveral before we have ſhewed to him. And when he has finiſhed his Charge, it is not inconvenient to give the Articles in writing to the Jury, that they may the better and more eaſily anſwer their Knowledges; for perchance the Jury cannot ſo methodically ſet down their own Meanings; therefore the Surveyor may correct the Form, ſtill retaining the Meaning and Intent of the Jury. Then let him read to them, that they may allow or diſapprove the ſame: and if they doubt any thing, he may give them a Day or more (as he ſees occaſion) to conſult and deliberate, and then adjourn the Court for that time,

Immediately after the Charge ended, the Surveyor is to make Proclamation in the Name of the Lord of the *Mannor*, that every Tenant do forthwith produce his Deeds, Copies, Leaſes and other Evidences, to the end they may be entred into a Book of Parchment for Continuance.

The manner of theſe Entries is as followeth:

Intrationes omnium & ſingularum Chartarum, Coplarum, Indenturarum, omniumque aliarum Evidenc' Tenentium ibidem fact. 22 *die Octobris Anno Regni noſtri* Caroli II *Dei Gratia, Angliæ, Scotiæ, Franciæ & Hiberniæ Regis, Fidei Defenſoris,* &c. *viceſimo quinto Annoque Domini* 1673. *ut ſequuntur:* viz.

Chartæ liberorum Tenentium: and under this Head ſet down all Free-hold-eſtates. Thus:

Charta Liberorum Tenentium. Thorne Townſhip Free-holders.

Socage	Abraham Knowles, *holdeth freely to him and his Heirs for ever, by Deed indented, bearing Date the* 27th *of* May *in the* 13th *Year of the Reign of King* Charles *the Firſt*, &c. *made and granted by, and from* Solomon Smith *of* &c. *All that Meſſuage or Tenement* (expreſſing the very Words of the Grant) *On which Grant there is a Deed of Feoffement of the ſame Date, with Livery of Seiſin thereon paſt accordingly; by the yearly Rent and Services of*——	Fealty, &c *s:* xiij.	*d.* iv.

The Particulars granted by this Deed.

	A.	*R.*	*P.*
The Manſion-houſe, Out-houſing and Site, conſiſting of an Orchard, 2 Gardens, 2 Yards, containing together	00	03	18
A Cloſe or Meadow called *Home Cloſe*, containing ——	06	02	11
Another Cloſe called *Well Cloſe*, containing —— ——	09	01	10
Of Meadow lying in 3 parcels in *Long Mead*, containing	16	03	07
A Cloſe of Arable Land, called *Bownſe*, containing ——	10	01	19
Arable in *South-field*, in 6 parcels, containing ——	04	02	00
A Cloſe called *Fearn-Cloſe*, containing 12 Beaſt-gates, at 12 *s. le Gate*, —— —— —— —— —— —— ——	12 *Gates*		
In the great Moore, at 6 *s.* 8 *d. per Gate*, —— —— ——	20 *Gates.*		
On the Downs, depaſturing for 90 Sheep, at 3 *d. le Gate* ——	90 *Gates.*		
Common (*ſans ſtint*) on the Moors.			

Thomas Richardſon, *holdeth by Copy of Court Roll bearing Date the* 18th *of* October, *in the ſixth Year of the Reign of our Sovereign Lord King* Charles *the ſecond, of the Surrender of* M. G. *Two Meſſuages or Tenements* (expreſs the Words of the Copy) *late in the Occupation of* S. K. *and before that in the Occupation of* O. N. *to him and Heirs, at the Will of the Lord, according to the Cuſtom of the* Mannor, *for which he payed Fine* x *lb.* iii *s.* viii *d. and payeth Rent* per Annum. —— ——	*s.* xxv.	

After this write the Particulars, as before in the Free-hold.

If the Eſtates be for Lives, then the Entries muſt be according to the Words of the Copy; and at the Foot of the Entry of every Copy he ought to ſet down the Ages of the Tenants in poſſeſſion, and likewiſe of them in Reverſion, and other neceſſary particulars: in the Order following;

Audley

Audley Townſhip, Copy-holders for Lives.

Thomas Cooper, *holdeth by Indenture bearing Date the* 10th *of* Auguſt, *in the twenty firſt Year of King* James, *made and granted by and from* R. S. *All that Meſſuage or Tenement*, &c. (expreſſing the Words of the Grant) *for the Term of the natural Lives of the ſaid* Thomas Cooper *aged fifty three Years, of* Iſabella *his Wife now aged forty one Years, and of* James *their Son, now aged ſixteen Years ſucceſſively each after other, and payeth Rent* per Annum ——— } s. xv.

After this write your Particulars as before, and after them ſuch brief Notes or Memorandums as you ſhall ſee fitting, according to former Directions.

When this is done, then proceed to Leaſes, wherein the Surveyor muſt obſerve theſe following particulars.

Dies, Menſis, Annus. Partes inter quas facta eſt Dimiſſio. vel Indentura. Conſideratio conceſſionis. Particularia quæ per Indenturam conceduntur. Habendum, cum termino annorum aut vitarum pro quo aut quibus conceduntur, Redditus & tempora ſolutionis. Clauſulæ diſtrictionis, aut forisfactura. Conventiones & proviſiones, breviter, ſed diſtinctè. Quomodo obligatur ad warrantizandum Conceſſor, &c.

And this is ſufficient for the manner of entring all ſorts of Deeds.

The Order and Manner how the Juries Verdict is to be received.

COming near to the concluding of your other Buſineſſes, as are before directed to be done, you muſt haſten the Jury to perfect their Verdict, which effected, call them before you, and examine and compare the Articles with their ſeveral Anſwers thereunto, and reduce the ſame into an orderly Form, obſerving well the Subſtance of what they have found and preſented, and reading the ſame to them, and having their Approbation and Allowance thereof, cauſe the Clerk to ingroſs the ſame in Parchment accordingly, together with your own private Notes and Obſervations, and reading them over to them again, being ſo Ingroſſed, and they having ſet their Hands and Seals thereunto, demand of them if they be mutually agreed in this their Verdict, which when they have acknowledged, receive the ſame from the Foreman, (in the behalf of the reſt) and diſmiſs your Court.

After all this is done, the Surveyor is now at Leiſure to perfect his Perambulation and Survey of the Mannor, and to Ingroſs the ſame.

The

The Manner how to Ingroſs a Survey.

A True and perfect Survey of the *Mannor* of *B.* in the County of *C.* being parcel of the poſſeſſions of *M. S.* who holdeth the ſame of our Sovereign Lord the King, as of his *Mannor* of *L.* in Fee, and common Socage (*or otherwiſe if the Tenure be other*) and by the yearly Rent of 6 *s.* 8 *d.* had, made and there taken, as well by Inquiſition, and the Oaths of a ſufficient Jury in that behalf, as by the View and particular Menſuration of all and every the Meſſuages, Lands and Tenements of, within, and belonging to the ſame. *Anno Dom.* 1671. *Annoque Regni Regis* Caroli II. 24.

After this (or the like) Title is to be expreſſed, 1. An Alphabetical Table of all the Tenants Names. 2. A general Rental of the whole *Mannor.* 3. The Names of the Out-boundaries of the whole *Mannor.* Mention the Mannor-houſe, and the Dimenſions thereunto belonging, and in whoſe Occupation the ſame is, whether in the Lord's own, or let by Leaſe or otherwiſe, to an Under-Tenant or Tenants, with the Rent thereof to the King. 4. What Parks, and what Number of Deer in them, and of what Kind. 5. What Fields, Cloſes and Demeſnes are in the Lord's own Hand. 6. What is let out by Leaſe, for Lives, Years, *&c.* as hath been already ſhewed. And under the Paragraph of Demeſne, enumerate all Mills, Mines, Games, as aforeſaid. 7. The Rectory, Parſonage, and Vicarage (if any be) and Glebe. 8. The Free-holders Land. 9. The Copy-holders. 10. The Tenants for Life.

Here note, That all the Lands in any *Mannor*, are one of theſe ſeven Tenancies, *viz.* 1. Demeſnes. 2. Glebe lands. 3. Free-holds. 4. Cuſtomary. 5. For Lives. 6. For Years. 7. At Will. And in this Order you ought to Engroſſe them.

Having thus far proceeded in the Engroſſement of your Book of Survey, and expreſſed at large the Quantity, Quality, Tenure and Value of all Particulars contained within the *Mannor*; you may briefly ſum up the whole as is expreſſed (for Example ſake) in this following *Analyſis.*

The

The Manor Consists of

- The Lord
  - Quantity — A. R. P. 1630 00 00
  - Value — lb. s. d. 720 00 00
- Demesnes in the use of
  - Lands
    - Number of Tenant. — 5
    - Quantity — A. R. P. 210 02 16
    - Rent — lb. s. d. 97 06 08
    - Value — 176 05 10
    - Ad demit. 78 19 02
  - The Tenants
    - Casualties made certain
      - Number of Tenants — 4
      - Rent — 32 10 06
      - Value — 58 16 04
      - Ad demit. 26 05 10
- Glebe Lands
  - Quantity — 116 Acres
- Free-holders of Inheritance
  - Number of Tenants — 10
  - Quantity — A. R. P. 732 03 16
  - Rent — 25 lb. a Fat Buck
- Tenement Lands.
  - Customary Lands,
    - Number of Tenants — 12
    - Quantity — A. R. P. 1000 00 00
    - Rent — lb. s. d. 242 00 00
    - Value — 470 00 00
    - Ad demit — 228 00 00
  - For Lives
    - Number of Tenants — 8
    - Quantity — A. R. P. 432 03 00
    - Rent — lb. s. d. 126 06 08
    - Value — 204 12 10
    - Ad. demit — 78 06 02
  - For Years
    - Number of Tenants — 24
    - Quantity — A. R. P. 730 02 17
    - Rent — lb. s. d. 216 09 03
    - Value — 410 16 01
    - Ad demit. — 193 06 10
  - At Will
    - Number of Tenants — 6
    - Quantity — A. R. P. 326 02 24
    - Rent — lb. s. d. 51 18 06
    - Value — 135 09 03
    - Ad demit. — 83 10 09

Of the Appellations, or Names of Lands in ſeveral Places.

HAving thus run through the ſeveral Particulars of *Survey* according to the *Law*, we will give you the ſeveral Diſtinctions of Lands by their Appellations in particular Places. Thoſe generally known are diſtinguiſhed into *Perches, Roods, Acres, Yard-lands, Plough-lands, Hides*, &c. But beſides theſe there are other Denominations given to Land, which we may ſuppoſe to have been anciently taken from Coins, as *Fardingdeals, Obolates, Denariates, Solidates*, and *Librates*.

The *Fardingdeal, Quadrantata terræ*, ſignifies a Rood, or a $\frac{1}{4}$ of an Acre. See *Crompton's Jur.* and *Reg. orig.* 1. We read in *Fitzh.* 87. of *viginti Libratas terræ*; as alſo *Reg. orig.* 49, & 248. importing, as it ſeems, ſo much Land as yields twenty Shillings Rent annually. So you may read farther *Reg.* 249. *centum Solidatas terrarum, tenementorum & reddituum.* But Roods and Acres differ many times according to the Cuſtom or Uſage of ſeveral places. Yet notwithſtanding the ſeveral Varieties, the Surveyor muſt make his Computation by the Standard; although perhaps it may be that the Lord's Demeſnes in ancient Surveys have been meaſured by the twenty-foot Pole, called *Menſura major*, and the Cuſtomary Land by ſixteen Foot and a half, called *minor Menſura*. So the French *Arpent* or Acre, containing 100 ſquare poles, is laid out in meaſuring Woods by the twenty two foot pole, which is called the *King's Arpent*; yet their other Lands are computed by the pole of 20, 19, or 18 Foot.

The *Ox-gang*, called by *Skene Bovata terræ*, is reputed to contain thirteen Acres; yet we find it ſometimes more, ſometimes leſs, as Cuſtom leads: and *Bovata* is properly uſed of Lands in *Gainour*, that is uſually ploughed.

The *Yard-land, Virgata terræ*, as Mr. *Lambard* holds, is ſometimes twenty, other times twenty four, and ſometimes thirty Acres; and it is not reputed in Demeſne, but in Gainour.

A *Plough-land* or *Carue of Land, Carucata terræ*, is ſaid to contain four Yard-lands at thirty Acres to the Yard-land; that is, *quantùm aratrum arare poteſt in novali tempore*.

A *Hide of Land, Hida terræ*, is ſaid to be ſuch a portion of Land as may be tilled with one Team in a Year and a Day, according to their ſeveral Tilths and Seaſons; and ſo *Crompton* affirms it to be 100 Acres by Statute, and ſo confounds *Hida* with *Carucata*. Others ſay that every Hide of Land contains four Plough-lands at 120 Acres, and ſo four Hides make a Knight's Fee.

A *Knight's Fee, Feodum Militare*, is ſo much as is ſufficient yearly for the Maintenance of a Knight and his Retinue with convenient Allowance and Revenue, which in the time of *Henry* the Third was fifteen pound. But Sir *Thomas Smith* in his Book *de Rep. Anglor.* rateth

rateth it at 40 *l. per Annum.* But *Cambden* records it to be 680 or 800 Acres. After ſome Computations it contains 5 Hides of Land, each Hide 4 Yard-lands at 24 Acres.

In the Dutchy of *Lancaſter* a Knight's Fee contains 4 Hides of Land, each Hide 4 Plough-lands, each Plough-land 4 Yard-lands at 30 Acres, amounting in the whole to 1920 Acres.

Two Knights Fees makes a *Cantred*, 2 Cantreds and a half make a *Barony*, and one Barony and a half makes an *Earldom*, that is to ſay, 38400 Acres.

But although theſe proportions of Land do not always hold with their Titles of Honour, yet their Denominations continue their Original Inſtitution; and however they may be diſmembred *quoad quantitatem*, yet the Right and Dignity is indiviſible; inſomuch as if a Capital Meſſuage be *Caput Comitatus vel Baroniæ*, it may not by any means be parcelled. And the Relief depends upon the Dignity after the firſt Allotment; *viz.* 100 *s.* for a Knight's Fee, 100 Marks for a Barony, and 100 *l.* for an Earldom. See *Magna Charta.*

In the laſt place, the Surveyor is to obſerve that the Tenants of Mannors holding freely by Charter in ancient Demeſne cannot be impleaded nor impannelled upon Enqueſts out of the ſame Mannor, and they are Toll-free for all things concerning their Suſtenance and Husbandry, and exempt from Contribution towards the Expences of Knights of the Shire that ſerve in Parliament. *F. N. B.* 14, and 128. Of theſe there are ſeveral ſorts: as,

Infeoffing with *Toll* implies Freedom from Cuſtom, *&c.*

With *Caruage*, from Taxation by Carues.

With *Bruck-bote*, from repairing and re-edifying Bridges; as with *Burgh-bote*, being the ſame for Caſtles.

Footgeld, implies a Privilege to keep Dogs within the Foreſt, not being expeditated or lawed without Controul.

Waives, *Weifs* or *Waived Goods* import ſuch Goods and Chattels as being ſtolen are left or forſaken by the Thief in his Flight.

Infangthefe enables the Lord of the Mannor to judge of Felons inhabiting within his Fee: as *Utfangthefe* to judge, or at leaſt to execute Judgment of Felons apprehended within Fee.

For Accrewments to the Lord of the Mannor by Felons, not only their Goods both real and perſonal, are forfeited, but alſo their Lands non entailed eſcheat *poſt annum diem & vaſtum*, except in Gavel-kind and ſome peculiars.

Baronies infeoffed with them had formerly power to diſpoſe of Villains, their Children, Goods and Chattels.

Abiſherſing, aliàs *Miſherſing*, implies both Forfeitures and Amerciaments of all Tranſgreſſions within the Fee, and alſo the Immunity from the like penalty.

Bloudwite is all Amerciaments of Courts for ſhedding of Blood.

Eſtovers

Eſtovers granted out of Woods or Forreſts include *Houſe-bote*, and *Plough-bote*.

The Concluſion.

IN this ſhort and ſmall *Tract* there hath been an Endeavour to lead you, as by a Clew, through the *Legal Part* of what you had before from the *Mathematical Artiſt*. We have not troubled you with *Charts* or *Tables* to be as *Fac Simile's* Whoever undertakes the Work of a *Surveyor* without ſome Knowledge of the *Law*, can with all his Art reduce it to no Certainty: And any Art without Certainty is like running in a Circle, where there is neither Beginning nor End. You have in this little Tract the Nature, Quality, Appurtenants, Appendants and Extents of a Mannor: If you receive that Satisfaction which was intended and deſired, then you have little cauſe to complain that your time is ill ſpent in the Peruſal. However, 'tis hoped you ſhall receive a greater Advantage by the Inſpection, than the Author expects Applauſe for his pains, becauſe he knows that *facile eſt addere*.

AN

AN
APPENDIX
To the WHOLE;
CONTAINING
PRACTICAL
OBSERVATIONS
Relating to the
Whole BUSINESS of
Land-Surveying.

By S. CUNN.

London, Printed in the Year 1722.

THE APPENDIX.

The Tenth BOOK.

CHAP. I.

Of Inſtruments uſed in Surveying Land.

INSTRUMENTS uſed in Surveying are, either, to meaſure, or lay down the Lengths of Lines, or their Poſitions.

The moſt proper Inſtruments for meaſuring Lengths, in Towns, Streets, or any other Buildings, are 5 Foot and 10 Foot Rods, and a Chain of 50 Foot long; for Fields and Woods a Chain of 66 Foot or 4 Poles, conſiſting of 100 Links, each containing 7 Inches and $\frac{92}{100}$; and a Rod whoſe length is equal to $\frac{1}{10}$th part of the Chain, that is 10 Links, or 6 Foot 7 Inches and $\frac{92}{100}$: For Roads the Wheel.

The Inſtruments uſed for taking the Poſitions of Lines are of two kinds.

With ſome we take the Poſition of a Line, by the Angle which that Line makes with the Meridian, uſing a Box and Needle; as with the *Theodolite*, the *Circumferentor*, the *Plain Table*, the *Perambulator*, the *Peractor*, &c. And this is uſually called the *Bearing of the Line*.

With

With others we take the Poſition by the Angle that the Line makes with any other given in Poſition; as with the Limb of the *Theodolite*, the Limb of the *Semicircle*, the *Frame* of the *Plain Table*, the *Bevel*, the *Chain*, or *Rods*.

All other Inſtruments either differ from theſe only in their Names, or elſe are contained in them.

But with ſome of theſe Inſtruments, very conveniently we take the Poſition in both manners, at one Obſervation; as with the *Theodolite*, the *Semicircle*, or the *Plain Table*.

With ſome of theſe Inſtruments we take the Angle it ſelf, as with the *Bevel*, or with the *Plain Table* covered with a Sheet of Paper; and with others, we expreſs the relative quantity of that Angle by Numbers. So when we uſe the Chain we expreſs the Angle by Sextants, Links and tenth parts of a Link; when we uſe Rods, we expreſs it, by Sextants, and centeſimal parts of a Rod; and when we uſe other Inſtruments, we expreſs the Angles by Degrees and Minutes.

We alſo obſerve, that of *Theodolites* and *Semicircles* there are various kinds; in ſome the Box is fixt to the Plate, in others to the Index. And the working with each of theſe varies according to the manner of their Numbering.

As for Roads, the Wheel with its Indices ſhewing the Diſtance, and its Box and Needle with Sights ſhewing its Bearing or Poſition in reſpect of the Meridian, is an Inſtrument ſpeedy and ſufficiently exact; provided we reject the Breadth of the Road, and only regard the Bearing and Length.

Laſtly, Inſtruments for plotting, are a Scale decimally divided the whole Length, cloſe to both the Edges; and at every tenth Diviſion numbered 0, 1, 2, 3, 4, *&c.* denoting Chains; the numbering ſo ordered that we may count either from the Right to the Left, or from the Left to the Right; and a *Protractor* always to be divided numbred and fitted to your Inſtrument.

For all *Circumferentors* (either ſo diſtinctly, or uſed as ſuch, *viz*, when contained in the *Theodolite*, *Semicircle*, or *Plain Table*) Let the Numbers in the *Protractor* encreaſe contrary to thoſe in the Box; But when the Box and Needle takes the Bearing, as the *Peractor* or *Perambulator* doth, the Numbers of the *Protractor* muſt encreaſe as thoſe in the Box. And for the Limbs of all *Theodolites*, *Semicircles* and *Plain Tables*, if the Circuit be made {according / contrary} to the Numbers on the Limb, the Numbers of the *Protractor* moſt conveniently encreaſe the {contrary / ſame} way with the Numbers on the Limb of the Inſtrument.

CHAP.

CHAP. II.

To observe the Position of a Line by any of the preceeding Instruments.

1. *By the* Circumferentor.

THE Box of the *Circumferentor* is divided into 360 Degrees, and numbred in 4 Quarters, from the North and South both to the East and West, by the Figures 10, 20, 30, 40, 50, 60, 70, 80, 90, but these Divisions are also numbred from the North towards the East or West, all round, till they end at the North again; by the Figures 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, and so on to 360. Of these two ways of numbering, the latter is properly the *Circumferentor*, and the former the Traversing Quadrants or Quarters.

Now if it be required to observe the Bearing of the Line A B (Fig. 1.), the Instrument standing at A. The Flower-de-luce being towards you, direct the Sights to B; and the South End of the Needle will point at 207 Degrees in the *Circumferentor*, and at S. W. 27. in the Traversing Quadrants.

And if you were going round the Field, and so next to observe the Bearing of the Line B C, at B; turn the Index about, the Flower-de-luce being towards you, till through the Sights you see the Hair cut C; then will the South end of the Needle point at 111, in the *Circumferentor*, (which is the Bearing, always counted from the North, and in these Examples indeed Eastward); and at S. E. 69 in the Traversing Quadrants; which is the Bearing always counted from the North or South towards the East or West. Here we may note, that the Bearing taken with the *Circumferentor* may be any Number of Degrees not exceeding 360, but, that with the Traversing Quadrants never exceeds ninety Degrees.

When you suspect the Needle doth not play well; direct your Index to your Mark, and note the Degrees pointed at by the Needle in a waste Piece of Paper; then with a clean Knife, or a Key, or any other polished Bit of Steel, which hath touch'd a Loadstone, move the Needle, by applying it to the Box, and examine when it hath settled again, what Degrees it then points at, your Index being still directed to the preceeding Mark; and if the Degrees are the same, they may be entred in the Field-Book; but if not, the Cap and Pin must be cleansed with some brown Paper and a little Puttey, and thereby freed of such Dust or Dampness as hath gotten to it; if after all the Needle doth not play freely, screw in a new Pin, or use another Needle, or do both; these Necessaries every Surveyor ought to have in his Pocket while he is in the Field.

If you ſuſpect any Error in the Bearing of any Line already taken, ariſing, from the Needles being acted on by ſome hidden Magnetick Power, or from your own Miſtake in obſerving the Degrees pointed at; the Doubt may be cleared and the Error corrected at the next Station; thus,

Having come to B (Fig. 1.), the Flower-de-luce being from you, look back to A, and then will the South end of the Needle point at 207 degrees in the *Circumferentor*, and at S. W. 27 degrees in the traverſing Quadrants; juſt as it did at A.

Laſtly, if you have no Reaſon to ſuſpect the Needle, and it is moſt convenient to plot by it, the ſpeedieſt way is to place the Inſtrument only at every other Angle; and there to take the Bearings of the two Lines conſtructing that Angle.

So, if you would obſerve the Bearings of the Lines of Fig. 1; firſt, place the Inſtrument at B, and with the Flower-de-luce from you, direct the Sights back to A, ſo the South end of the Needle will point at 207 degrees in the *Circumferentor*, and at S. W. 27 degrees in the Traverſing Quadrants which is the bearing of A B; then with the Flower-de-luce next you, direct the Sights to C, ſo the South end of the Needle will point at 111 degrees in the *Circumferentor*, and at S. E. 69 degrees in the Traverſing Quadrants, which is the bearing of B C.

Now, place the Inſtrument at D, the Flower-de-luce being from you, direct the Sights back to C, ſo the South end of the Needle will point at 44 degrees 30 minutes in the *Circumferentor*, and at N. E. 44 degrees 30 minutes in the Traverſing Quadrants, which is the bearing of C D; and directing the Sights to E, the Flower-de-luce being towards you, the South end of the Needle will point at 102 degrees 15 minutes in the *Circumferentor*, and at S. E. 47 degrees 45 minutes in the Traverſing Quadrants.

In like manner work at F, *&c.* always keeping the Flower-de-luce from you, when you look backwards, and towards you when you look forwards; ſo will the South end of the Needle point at the Degrees of the bearing in both Caſes.

To protract any Line whoſe Bearing is taken by the Circumferentor.

FIRST, draw Lines parallel to one another quite through the deſigned Draught, at Diſtances not exceeding the breadth of the Diametrical part of your *Protractor*, as in Fig. 1. and mark them with *N.* and *S.* for North and South; then lay the Center of the *Protractor* on the given Point A, repreſenting the Station A in the Field, and, by Help of the Diviſions continued beyond the Ends of the Diameter of the *Protractor*, lay the Diameter parallel to thoſe North and South Lines, the beginning of the numbering Northwards, when the degrees are fewer than 180, but Southwards when more; the *Protractor* being thus placed cloſe to the Limb againſt 207, the degrees of the Bearing, make a Mark

and

and to it draw the Line A B; and ſo will A B have a Bearing like to that, which you obſerv'd the Line A B to have in the Field. In like manner you may lay down the bearing of any other Line, as B C; if you obſerve to lay the beginning of the numbering Northwards, when the degrees are leſs than 180 degrees, and Southwards when more.

And if you would lay down the bearing of any Line A B from any aſſigned Point A, with the Traverſing Quadrants; after you have drawn North and South Lines as before, the North being upwards, write Eaſt on the right Hand ſide of the Map, and Weſt on the Leſt. Now lay the Center of the *Protractor* and *Diameter* as before taught; ſave that inſtead of obſerving the Number of the degrees, you turn the Limb of the *Protractor* Eaſtward, when the bearing is N. E. or S. E. and Weſtward, when it is N. W. or S. W.

The *Protractor* being thus placed, againſt S. W. 27, make a Mark and to it draw the Line A B, and ſo will A B have a Bearing like to that which A B was obſerv'd to have in the Field. In like manner you may lay down the bearing of any other Line.

2. *With a* Theodolite, *both by the Limb, and by the Box and Needle.*

BEfore you engage in a Survey, you ought to conſider the numbering of your Inſtrument; thus, when the Eye is conceived plac'd in the Center, conſider whether the Numbers encreaſe from the Left to the Right, or from the Right to the Left; or according to the Farmer's familiar Phraſe, whether the Numbers encreaſe with or againſt the Sun's Motion.

And then obſerve, that with a *Theodolite* whoſe Box is fix'd to the {Plate / Index} the Circuit is moſt conveniently made {with / againſt} the increaſing of the Numbers; and the fixt Sights ſhall always be directed to the {next / laſt} ſtation, and the Index to the {laſt / next}. And then if you keep the beginning of the degrees towards you when you direct the fixt Sights, and the Flower-de-luce towards you when you direct the Index; the degrees cut by the end of the Index which is next you are the degrees of the Angle; and the degrees pointed at in the Box by the South end of the Needle, give the bearing of the next Length. And this bearing will be in all reſpects the ſame with that taken with the *Circumferentor*; provided that the Box be divided and numbred like that of the *Circumferentor*.

This double Obſervation is of great uſe to the Surveyor; for hereby he may either plot by the Angle or by the Bearing, or both, as he ſhall find moſt convenient; and alſo he may prove his Obſervation before he moves his Inſtrument. For, of the Numbers expreſſing

preſſing the bearing of the Lines forming any Angle, if the leſſer be ſubtracted from the greater, and the Remainder be {encreaſed / diminiſhed} by 180 Degrees when {leſs / greater} than 180, the Reſult will give either the Angle it ſelf or its Supplement to 360 degrees.

When we uſe a *Theodolite* with a Box fixt to the {Plate / Index} and the Numbers in the Box encreaſe the {ſame / contrary} way with the Numbers on the Plate, as they generally do, or as I would chuſe to have them; then a *Protractor* being numbred contrary to the Numbers in the Box, will be fitted to lay down the Plan, either by the Angles taken by the Limb, or by the bearing taken by the Needle, or by both together in order to prove the Truth of each other. And then alſo may the Truth of the Angle or bearing be proved, before the Inſtrument is moved from the Station by either of the two following Rules.

If to the preſent bearing be added 180 degrees, and from the Sum you ſubſtract the laſt bearing; then the Remainder will be the preſent Angle.

And if to the preſent Angle you add the laſt bearing, and from the Sum ſubſtract 180; then will the Remainder be the preſent bearing.

But if the Degrees to be ſubtracted are more than thoſe from which they are to be ſubſtracted; the latter muſt be encreaſed by 360, and then ſubſtract.

And if the Remainder be more than 360, then abate 360, and the Reſult gives the Degrees required.

So, with a *Theodolite* that hath the Box fixt to the Index, and the Numbers on the Plate, while the Eye is conceived placed in the Center, encreaſe from the Left to the Right, but thoſe in the Box the contrary way, and ſo moſt proper to work againſt the Sun; if you would take the bearings of the Lines of Fig. 1. and if you would begin from any aſſigned Angle, ſuppoſe A; then, your Inſtrument being planted at A, direct the Index to the next Station at B, and the South end of the Needle will point at 207 degrees in the *Circumferentor*. And for the following Angles and Bearings when the Inſtrument is

planted at {B / C / D / E / F / G} direct the fixt Sights to {A / B / C / D / E / F} and there ſcrew the Inſtrument faſt, and then direct the Index

Index to C, D, E, F, G, A and the end of the Index next your Eye will cut on the Limb the Angles

°	′
84.	00
113.	30
237.	45
49.	35
102.	40
234.	00

and the South end of the Needle will, as in the *Circumferentor*, point at

°	′
111.	00
44.	30
102.	15
331.	50
254.	30
308.	30

And with a *Theodolite*, that hath the Box fixt to the Index, and the Numbers of the Plate contrary to those of the Box, while the Eye is conceived plac'd in the Center, encrease from the Right to the Left, and so most proper to work according to the Sun's Motion; if you would take the Angles and the Bearings of the Lines, of Fig. 1. and begin from any assigned Angle, suppose A; then your Instrument being planted at A, direct the Index to the next Station G, and the South end of the Needle will point at 231° 30′ in the *Circumferentor*. And for all the following Angles and Bearings, when the

Instrument is planted at G, F, E, D, C, B direct the Sights to A, G, F, E, D, C

and there screw the Instrument fast, and then direct the Index to F, E, D, C, B, A

and the end of the Index next the Eye will cut on the Limb the Angle

°	′
234.	00
102.	40
49.	35
237.	45
113.	30
84.	00

and the South end of the Needle as in the *Circumferentor* will point at the bearing

°	′
285.	30
208.	10
77.	45
135.	30
69.	00
333.	00

But with a *Theodolite* that hath the Box fixt to the Plate, and the Numbers on the Plate as well as those in the Box (the Eye being placed in the Center) encrease from the right to the left, and therefore most proper to work contrary to the Sun's Motion; if you would take the Angles and the Bearings of the Lines of Fig. 1. and begin at an assigned Angle A; then your Instrument being planted at A, direct the fixt Sights to B, and the South end of the Needle will point at 207° 00′, as in the *Circumferentor*, and as in the first Example. And for all the following Angles and Bearings, when

the Instrument is planted at { B C D E F G } direct the fixt Sights to { C D E F G A };

then screw the Instrument fast, and direct the Index to { A B C D E F }.

so will the end of the Index next the Eye cut on the Limb, the Angle { 84. 00 / 113. 30 / 237. 45 / 49. 35 / 102. 40 / 234. 00 };

and the South end of the Needle, as in the *Circumferentor*, will point at the bearings { 111. 00 / 44. 30 / 102. 15 / 331. 50 / 254. 30 / 308. 30 };

both as in the first Example.

Also with a *Theodolite*, that hath the Box fixt to the Plate, and the Numbers on the Plate, as well as those in the Box, the Eye placed in the Center; encrease from the Left to the Right, and therefore most proper to work according to the Sun's Motion; if you would take the Angles and the bearings of the Lines of Fig. 1. and begin at an assigned Angle at A, direct the fixt Sights to G, and the South end of the Needle will point at 23° 30′ as in the second Example. And for all the following Angles and Bearings when the Instrument

ment is planted at { G F E D C B } direct the fixt Sights to { F E D C B A };

then ſcrew the Index faſt, and direct the Index { A G F E D C } to

°	′
234.	00
102.	40
49.	35
237.	45
113.	30
84.	00

and ſo will the end of the Index next the Eye cut on the Limb the Angle;

°	′
285.	30
208.	10
77.	45
135.	30
69.	00
333.	00

and the South end of the Needle as in the *Circumferentor* will point at the bearings

both as in the ſecond Example.

With either of theſe four Inſtruments, the Angles and the Bearings of the Lines are taken, at once ſetting the Index, as eaſily and expeditiouſly as the Angle it ſelf only; which evidently appears from the four preceeding Examples. And the Truth of theſe Obſervations may be readily proved by either of the Rules already laid down.

For, the Inſtrument being planted at B, in the firſt and third Examples; if to 111° 00′ the bearing there taken, you add 180°. 00′ and from the Sum 291°. 00′, take the laſt bearing 207°. 00′, there will remain 84° 00′, which gives the Angle taken at B, exactly as there obſerved; and proves the Angle and theſe two bearings to have been truly obſerved.

In like manner, the Inſtrument being planted at C, in the ſame Examples; if to the bearing there taken, 44°. 30′, you add 180° 00′ and from the Sum 224°. 30′, you ſubſtract 111°. 00′, the bearing taken at the laſt Station; the Remainder 113°. 30′ gives the Angle at C exactly as it was there obſerved; which proves that the Angle and alſo the laſt and preſent bearings are truly obſerved.

Alſo

Alſo the Inſtrument being planted at D; if to the bearing there taken 102°. 15′, you add 180°. 00′, and from the Sum 282°. 15′, take 44°. 30′ the laſt bearing; the Remainder 237°. 45′ gives the Angle at D. as there obſerved.

But the Inſtrument being planted at E; if to the bearing there taken, 331°. 50′, you add 180°. 00′, and from the Sum 511°. 50′, you ſubſtract 102°. 15′, the laſt bearing; the Remainder 409°. 35′ leſſen'd by 360°. becauſe greater than 360, gives 49°. 35′, the Angle at E. And ſo of all the reſt.

And in like manner may the Angles and Bearings be compared in the ſecond and fourth Examples.

Or the Angles and Bearings may be compared by the ſecond Rule thus. The Inſtrument being planted at B; if to 84°. 00′ the preſent Angle, you add 207°. 00′ the laſt Bearing, and from the Sum 291°. 00′ you take 180°. 00′, the Remainder 111°. 00′, gives the preſent Bearing, as obſerved.

The Angles and Bearings being truly taken, it remains to ſhew how

To Plott, and therein to diſcover and correct an Error before it is communicated to the following Part of the Work.

HAving provided your ſelf with a *Protractor*, whoſe Numbers encreaſe contrary to thoſe in the Box, draw all over your deſigned Draught parallel Lines, as in plotting Obſervations taken with the *Circumferentor*.

Then from ſome Point convenient to repreſent your firſt Station, as in the {first and third / ſecond and fourth} Examples, from A, lay down by the bearing {207°. 00′ / 231. 30} the firſt Line {AB / AG} as taught in plotting Obſervations taken with the *Circumferentor*.

Then on the Point {B / G} lay the Centre of the *Protractor*, and its Diameter on the Line {AB / AG} produced both ways if need require, ſo that the beginning of the Degrees may be towards the laſt Station if the Angle be leſs than 180 Degrees, but the contrary way if greater, then at the Edge of the *Protractor* make a Mark againſt {84°. 00′ / 234. 00} the Degrees of the Angle {B / G}, and draw the Line {BC / GF}. Now turn the *Protractor* about on its Center, till its Diameter be parallel to the Meridians, ſo that the beginning of the Degrees be towards the North, when the bearing is leſs than 180, but contrarily when more;

more; and then if the Line {BC / FG} cut the bearing {111° 00' / 285° 30'} on the Edge of the *Protractor*, that Line is truly laid down: Otherwiſe not.

In like manner, may any other Angles be examined, and if found erroneous, the Error may be corrected, before it is communicated to the following Part of the Work.

And we may obſerve, that, if the Plot be laid down by the bearings of the Lines, thoſe bearings may be examined by meaſuring the Angles as ſoon as plotted.

Though this Method ſufficiently recommends it ſelf, both in reſpect of Diſpatch as well as ACCURACY; I do not expect it will be practiſed by any but the Unprejudiced. For He, who hath ſurveyed much Land, with a *Circumferentor* alone, or with a *Semicircle* or *Theodolite*, without a Needle or with any other Inſtrument, that doth not afford a double Obſervation; He, I ſay, hath not provided a Check to his Frailty, and will ſcarce forſake his old Way, becauſe he will not accuſe himſelf.

There are two other ways to uſe theſe *Theodolites*, each equally exact with the former, but not ſo expeditious. One way is to take the bearing with the Traverſing Quadrants; the other is to take the Bearing with the Degrees on the Limb. But the Angle is always taken as above.

If you would uſe the Traverſing Quadrants, then the obſerving, the plotting, and the Proof in plotting, are all as eaſily, ſpeedily, and exactly done as by the firſt Method; but the Proof of the Obſervation in the Field, though equally true with the former, is neither ſo eaſily performed, nor ſo eaſily reduced to one ſingle Rule. But the Perſon who is reſolved to plot by the Traverſing Quadrants, had beſt take the Obſervation both by the *Quadrants* and by the *Circumferentor*: and then prove the Obſervation in the Field by the *Circumferentor*, and the plotting by the *Traverſing Quadrants*.

Laſtly, If you would take the Direction by the Diviſions on the Limb with a *Theodolite*, whoſe Box is fixt to the Plate, then (after you have taken the Angle, as before taught) turn the Inſtrument about till the North end of the Needle point at 360 degrees in the Box, and ſcrew it faſt; now direct the Index to the next Station, and the end next you will give on the Limb the Direction in Degrees and Minutes as in the former Examples.

But with a *Theodolite*, whoſe Box is fixt to the Index, if you would take the Direction by the Diviſions on the Limb; then (after you have taken the Angle as before taught) direct the fixt Sights to the next Station, and ſcrew the Inſtrument faſt, and turn the Index about till the North end of the Needle point exactly at 360 degrees in the Box; and then will the end of the Index neareſt to the South end of the Needle cut on the Limb the Direction in Degrees and Minutes. But the *Protractor* to lay this bearing down muſt be numbred contrary to the Limb on the Inſtrument.

The great Advantage uſually propoſed by this laſt Method, is, that the Degrees on the Limb are larger and more diſtinctly cut, and conſequently more nearly eſtimated than thoſe in the Box. But conſider that you can no better bring the Needle to point at any one Degree, than you can eſtimate its Poſition in any other Degree; and that ſince we uſe the Needle, all the Objections made in one Method are incident to the other; and then you may eaſily conclude that the Advantage is only imaginary.

Beſides, here we are obliged to take two Obſervations, either of which take up as much time as the one Obſervation uſed in the former Method; which renders it not ſo fit for a Practitioner.

Of the Uſe of theſe *Theodolites*, I have one thing more to advertiſe, *viz.* To meaſure and caſt up the Content of one large ſingle Wood or Common, where there are ſome ſcores of Angles to be taken; the ſafeſt way is to caſt, without plotting, by Help of the Needle. And in this Caſe I would take the Directions both with the *Circumferentor* and the *Traverſing Quadrants*; and in the Field prove the Directions taken with the *Circumferentor* by the Angles taken by the Limb; and then, ſtill in the Field, prove both Lengths and Directions, in calculating a Traverſe, by Help of a Traverſe Table; and laſtly from this Traverſe (at Leiſure) deduce the true Content.

But the Traverſe Tables that are now extant, are but Specimens of thoſe which are fit for Uſe; Inſtruments are not ſufficiently exact, and Trigonometrical Operations too laborious; and therefore I muſt defer this way of Computation, till ſome Perſon who hath Leiſure and Patience to ſerve the World, in calculating ſuch a Table is reſolved to do it; If I can procure it, as indeed I have ſome hopes thereof, it may be publiſhed with its Uſes in Practical Surveying and Navigation in a Pocket Volume.

Of any one of the four *Theodolites*, which have the Number of the Box contrary to thoſe *Theodolites* before deſcribed, one or more inconveniencies will always ariſe, uſe which of the three forementioned Methods you pleaſe.

It is true, the Angle taken by the Limb is perform'd as taught in the preceeding Rules; but ſince it is not ſafe to work by the Limb only; if you uſe the *Circumferentor* as taught in the firſt Rule, you muſt either ſubſtract the Direction from 360 Degrees, and enter the Remainder inſtead of the Direction pointed at by the Needle; or elſe uſe two *Protractors*, which will be troubleſome, and alſo apt to cauſe Miſtakes by uſing the one for the other.

If you uſe the *Traverſing Quadrants* only, then indeed the Uſe is in all reſpects the ſame with the preceeding ones: but theſe as I have already ſhewn is not ſo expeditious as, nor more exact than, the Method firſt laid down.

If you will take the Direction by the Limb, and ſtill make one *Protractor* plot both Obſervations, you muſt direct your Inſtrument twice,

twice, whereas by the firſt Method laid down, it might be done at once.

Laſtly, of *Theodolites* theſe are beſt which have Teleſcopes with plain Sights on them; and ſo contrived that the Surveyor may at any time adjuſt any ſmall Accident, without coming to a Workman, and that both of them may be elevated or depreſſed at leaſt ten degrees; one of theſe Teleſcopes inſtead of the fixt Sights, the other inſtead of the moveable ones; and as long a Needle as will play well, with other the like Conveniencies, ſufficiently known to a skilful Inſtrument-maker.

To obſerve with a Semicircle that hath a Box and Needle.

A Semicircle is juſt half the *Theodolite*, and admits of juſt as many Varieties, it is numbred on the Limb to 180 Degrees, and in an Arch concentrick to this is numbred under 10, 20, 30, *&c.* with the Numbers 190, 200, 210, *&c.* to 360. Its Uſe in all reſpects (both to the Plate and Box) is the ſame with the *Theodolite*; ſave in this, that when the End of the Index falls off the Plate; the Degrees cut on the Limb are to be taken from the farther Part of the Index from the Degrees of the inner Circle; and will be always more than 180 Degrees.

There are ſome other manners of numbering and dividing (and perhaps without a Box and Needle,) uſed in theſe Inſtruments; but they are not worth Notice.

The Peractor

IS part only of that *Theodolite* whoſe Box is fixt to the Plate; and the Directions for the *Theodolite* will ſerve for this; and our Author hath himſelf laid down

The Uſe of the *PERAMBULATOR*; to which I refer you. And as to the Diviſions on the Limb of the *PLAIN TABLE* with its Box and Needle.

LIke that of the *Theodolite*, or *Modern Circumferentor*; if the 360 Degrees of the Limb be upwards, and the Box and Needle ſcrewed to the Side of the Table; it performs in all reſpects the Uſe of the *Theodolite*, whoſe Box is fixt to the Plate. For lay the Edge of the Index on the Diviſion numbered 360, to that numbered 180; and turn the whole Inſtrument about, till through the Sights you ſee the next Station (the 360 being towards you as taught in the *Theodolite*) and there ſcrew it faſt; then turn the Index about upon the Centre, till you ſee your laſt Station, and ſo will the end of the Index

Index next you cut the Degrees of the Angle, and the South end of the Needle will give the Direction.

But if the Box be ſcrewed to the Index; it in like manner becomes a *Theodolite*, with a Box fixt to the Index.

If the Box and Needle be ſcrewed to the Staff; it is a *Circumferentor*.

If the Box be ſcrewed to the Table, and that ſide of the Frame be upwards, which is divided into four Nineties; it is the *Perambulator*.

If that ſide of the Frame is upwards, which hath only the 180 Degrees of the Semicircle numbred on it; then it is a Semicircle, either with the Box to the Plate or not; according as the Box is fixt to the Table or the Index.

And what hath already been ſaid of theſe Inſtruments may ſerve for Directions, to uſe the plain Table theſe ſeveral Ways, and need not be again repeated here.

And hence it ſeems that the Plain Table might properly be called *Panorganon*, in reſpect of Land-Surveying.

Indeed, if inſtead of the ſmall Holes for Centers to be uſed with a Protracting-pin by the Fiducial Edge of the Index, there were Conick Holes through the Tables; and alſo a Hole. being the next adjoyning great Segment of the ſame Cone made in the Index to ſcrew itto the Centers by a Conical Pin at the End of it; and the Fiducial Edge of the extream parts was filed away, ſo that when continued they would paſs thro' this Central Pin; and if the Diviſions on the Frame be cut as well as on the Limb of the *Theodolite*; and if alſo the Wood would neither ſhrink nor ſwell no more than Braſs; and a Teleſcope mounted on the Sights; and the back ſide of the Index brought alſo to a Fiducial Edge; then I ſhould think it a very compleat Inſtrument.

It remains to ſhew how to take Angles when we uſe the plain Table covered with a Sheet of Paper; but this hath been ſufficiently handled by our Author, therefore I ſhall content my ſelf with laying down a Method to correct an Error committed before it is communicated to the following parts of the Work: Though I do not any ways doubt but the Reader may, by what follows, learn the uſe of this plain Inſtrument.

Suppoſe you were to draw the Plan of the Field ALMNOPQR; (Fig. 2.) draw on the Table a Line to repreſent A L in the Field, and by your Scale lay down on the plan the diſtance you found A L in the Field to be, when you meaſured it with a Chain. Then planting your Table at L, lay the Index on A L, and turn the whole Inſtrument about till you ſee A, and then ſcrew it faſt, then turn the Index about on L, till through the Sights you ſee M, and draw L M; and by your Scale give it on the Table the ſame Length you found it to have in the Field, by meaſuring with your Chain.

Now

Now in order to examine the Length of L M, and alſo its Poſition in reſpect of A L; plant your Inſtrument at M, lay the Index at L M, and by turning the Inſtrument, direct the Sights to L, and there ſcrew it faſt; then direct the Index turn'd about on M, towards A in the Field, and if the Edge doth not cut the Point A in the Table, the Line L M is falſe either in Poſition or Length, and therefore muſt be examined and corrected before you proceed.

The Line L M being truly laid down, plant the Inſtrument at M, and lay the Index on L M, and direct the Sights to L, by turning round the whole Inſtrument, and then ſcrew the Inſtrument faſt; now turn the Index about on M, till through the Sights you ſee the Hair cut N, and by the edge of the Index draw a ſtrait Line; and by your Scale, from N lay the Length N M equal to what you meaſured it in the Field.

But to prove whether the Line N M is truly laid down both in Poſition and Magnitude; having Planted the Inſtrument at N, and directed the Index on N M to M, and there ſcrewed the Inſtrument faſt; from N direct the Index to either of the Marks L or A in the Field, and if the Index then doth not accordingly cut L or A on the Table, the Line M N is falſe; and muſt be corrected before you proceed.

And in like manner through the whole Survey you may proceed to lay down every Line, and examin it before you leave it, provided that you leave your Marks all ſtanding at every Station, by laying the Index on the laſt Line, and turning the Inſtrument about till thro' the Sights you ſee the Hair cut the laſt Mark; and then ſcrewing the Inſtrument faſt; if you turn the Index about on the Point repreſenting the Station where the Inſtrument ſtands, till you ſee any one of the Marks paſſed by, except the laſt of all; and if the Edge of the Index doth not cut on the Table, the Repreſentative of that point; the laſt Line is not truly laid down.

But when you are at any Mark, ſuppoſe N, if you cannot ſee any other Mark but M; ſet up ſome Mark *a*, from whence you may ſee ſome of the preceeding Marks, ſuppoſe L, as well as M and N; and from this point *a* examine the Truth of the poſition of the Line M N.

Or thus, you may ſet up a Mark *a*, any where in the middle of the Field, from whence all or ſeveral of the Angles may be ſeen; then the Inſtrument being at A, and the Index on A L, ſcrew the Inſtrument faſt; and turn the Inſtrument about on A, till you ſee *a*, and draw A *a*.

The Inſtrument being at L, the Index on L A, and the Index directed to A; let the Inſtrument be ſcrewed faſt; turn the Index about on L, till through the Sights you ſee *a*, draw by the Edge of the Index L *a*; and ſo will the point *a* be determined.

Then the Inſtrument being at M, the Index on L M, and the Sights directed to L, and then the Inſtrument ſcrewed faſt, turn the Index about on M, till through the Sights you ſee the Mark *a*

in the Field: then if the Edge of the Index doth not cut *a* in the Table; the Line L M is falſe either in Poſition or Magnitude.

In like manner the Table being at N, the Index on N M, and the Sights directed to M, and then the Inſtrument ſcrewed faſt: turn the Index about on N, and direct the Sights to the Mark *a*; and if the edge of the Index doth not cut *a*, on the Table; then MN is falſe either in poſition or magnitude.

Laſtly, inſtead of a Mark ſet up as *a*, you may uſe any remarkable Tree, Steeple, *&c.* not at too great a diſtance from you, whether it be in the Land you are then Surveying or not.

And when the Mark you have laſt uſed is at too great a Diſtance from you, or lies almoſt in the ſame ſtrait Line with that which you are about to lay down; then uſe ſome other Mark in its ſtead.

To take Angles with a Chain.

IN order to do this, provide three round Sticks, very ſtrait and about four or five Foot long. And if you were to take any Angle as D B C (Fig. 3.) firſt place one Stick upright in B, and there hold one end of the Chain, and let your Aſſiſtant carry the other end, and another Stick towards C, and direct him to move ſide ways, till the Stick held upright at E, be exactly in the right Line B C, where let him leave it.

Then let him take the end of the Chain and move towards D, and as before direct him to plant the third Stick upright in the Line B D at F.

Then meaſure the diſtance E F in Links and decimal Parts of a Link, if leſs than one Chain, and enter them in the Field-Book; ſo if the diſtance E F were 94 Links and 7 Tenths of a Link, they might be entered thus, $\overset{\text{parts}}{0 \cdot 947}$, denoting 0 Sextants, 947 parts.

In this Work great Care ought to be taken, that the Sticks be as ſtrait as a Workman can ſhoot them with a long Plane; and that they are planted either exactly perpendicular, or at leaſt ſo that the Sticks planted at B and E, and the Mark C may be exactly in the ſame plane and alſo the Sticks B and F, and the Mark D in another Plane.

But becauſe it is very difficult to erect a Stick exactly perpendicular; it will be eaſier to perform the latter; thus, plant the Stick as nearly perpendicular as you can; then move your ſelf backwards towards G, the farther the better, till your Eye, the Stick at B, and the Mark at C are all in one ſtrait Line, there ſtand and direct your Aſſiſtant to plant his Stick, ſo that the Stick at B exactly cover it from the top to the bottom.

But if it ſo happen that you cannot move backwards at all towards G; then having planted the Stick at B as upright as you can, let your ſecond Aſſiſtant move forwards towards C, and let him there

there direct your first Assistant to plant the Stick at E, so that it exactly cover the Stick at B, while you direct him to place it in a right Line with the Stick B, and the Mark at C. And the like Caution must be used in planting the Stick F. Nevertheless it will often so happen that the Mark at D may be a little shifted, and in this Case, time and trouble may be a little lessened; for having planted the Stick at F, nearly in a true Position, move forwards towards D, and direct your Assistant to incline the Stick at F, so that it exactly cover the Stick at B, then returning to B, direct your Assistant at D to place the Mark in a right Line with the Sticks B and F.

But, secondly, if the Line E F be longer than the Chain (as in Fig. 4.) lay out a Sextant: thus while the Chain was laid from B to E, set down an Arrow at H 50 Links; then let your Assistants hold the Chain's ends at H and B, while you with the middle in your Hand laying both Halves strait, set down an Arrow at I, and so constitute the Equilateral Triangle H B I; and therefore have thereby laid out the Angle H B I, a Sextant. Now the Chain's end still held at B, stretch it through the point I to K, where also set down an Arrow; Lastly, measure K F in Links and decimal parts of Links, which suppose to be 76 Links and 4 Tenths; and then shall be entred in the Field Book 1$^{s.}$ 764. implying one Sextant and 764 parts.

In like manner, if the Angle were more than two Sextants (as in Fig, 5.) then having laid off the Sextant H B I. Let your Assistants hold the ends of the Chain at B and I, while you with the middle of the Chain in your Hand set down an Arrow at L, constituting the Sextant I B L; and then as before the Chain being still held at B, lay it through L, and at the other end M set down an Arrow; lastly, measure M O, which suppose to be 43 Links and 5 Tenths and then enter in the Field Book 2^{s} .4 35; that is 2 Sextants and 435 parts.

If I would continue a strait line, I signifie it by entering in the Book 3 s. 000; that is 3 Sextants.

If an Angle be external, and so containing more than three Sextants (as in Fig. 6.) let one Assistant hold one end of the Chain at B, and let the other Assistant stand with the other end of the Chain at E, and there hold a Stick so that E, B and C, are in the same Plane as before taught, and also plant a Stick at F, so that the Sticks B and F and the Mark D be also in the same Plane. Then measure the Angle E B F, as already taught, and to it add the Sextants, and so will the Sum be the Measure of the external Angle C B D. So if the Angle G B D be 0 s. 947, then will the external Angle C B F be 3 s. 947. But if the Angle G B D be 1 s, 764, then the external Angle C B D will be 4 s. 764. And if the Angle G B D be 2 s. 435, then the external Angle C B D will be 5 s. 435.

Now to plot any of these Angles, thus taken (suppose that in Fig. 3.) chuse some Line divided into 1000 equal parts, and with this Line describe an Arch E R, and lay on it from E to F 947 equal parts and draw B D.

And

And if you would plot the Angle taken in Fig 4. from B with the length of the divided Line deſcribe an Arch E F, and lay thereon the length of the divided Line from E to K, and afterwards 764 parts from K to E, and draw the Line B F D, and you will conſtruct the Angle required.

And if you would plot the Angle of Fig. 5. then as before with the length of the divided line deſcribe the Arch E O, and thereon lay E P, P M, each equal to the Radius; and afterwards lay 435 equal parts from M to O, and draw B O; and you have the Angle as required.

Alſo if you would protract an Angle greater than three Sextants, (as the external CBD, in Fig. 6.) firſt continue the line CB, then from the Angle ſubtract three Sextants, and make the Angle G B D equal to the Remainder.

If you would protract by a *Protractor*, let it be made thus; let the Semicircle (Fig. 7.) be divided into three Sextants in the Points A and B. Then draw the blank lines C A, A B, B D, and divide each into 100 equal parts; and then transfer them to the Arches CA, AB, BD; laſtly, from the Center draw the Diviſions, which number thus, 10. 20, 30, 40, 50, 60, 70, 80, 90, I. 10, 20, 30, 40, 50, 60, 70, 80, 90, II. 10, 20, 30, 40, 50, 60, 70, 80, 90, III. But obſerve that with this order of numbering, the Work muſt be carried on againſt the Sun within the Field, and with the Sun's Motion without the Field. And the uſe of this is in all reſpects like that of other *Protractors*; for when the *Protractor* is placed as above, and you are to lay down 2 s. 435 parts, count out on the edge of the *Protractor* beyond II. towards III. 43 Diviſions, which anſwers to 2 s. 4305 and for the laſt place conceive every Diviſion ſubdivided into ten equal parts. and by the Eye eſtimate the parts required, which in this Example is 5, and falls in the middle between the 43d, and the 44th Diviſion; laſtly, againſt this eſtimated point make a Mark, to which from the Center draw a Line, and Angle as is required. Thus much of taking Angles by the Chain only when we work in the inſide of an open Field.

But if you would go on the outſide of a Field, or ſurvey a very buſhy Wood, as in Fig. 8. then inſtead of working according to the Order of the Letters A B C D, and againſt the Sun, work from A to F, and ſo to E with the Sun; and inſtead of taking the Angles themſelves within the Wood B A F, A F E, F E D, E D C leſs than three Sextants, take their Supplements to ſix Sextants, by adding three Sextants to the Angles GAF, HFE, IED, KDC; alſo inſtead of the Angle DCB within the Wood greater than three Sextants by the Angle L C D, take its Supplement to 6 Sextants, the Angle DCB without the Wood.

And then in the ſame Order proceed to plot from A to F, and ſo on to E; as before taught.

But when the Angles are each leſs than 3 Sextants and ſo all internal ones, as in Fig. 9. you may work as though you were within the Wood by taking the Angles FAG, HBI, KCL, *&c.* made by continuing the Lines E A, B A, B C, *&c.* for theſe Angles are equal to the internal ones, E A B, A B C, B C D, *&c.* becauſe vertically oppoſite to them.

And indeed the like Method may be obſerved in Fig. 8. provided that when we come to the external Angle BCD, that here we take its Supplement to 6 Sextants; and enter in the Field-book the quantity with the Word *Supplemental* added to it.

N. B. If you have two Chains, you may (as will be better) lay out the Sextants ſo, that each ſide of the equilateral Triangle be one whole Chain.

But take eſpecial Care that the Rings at the end of each tenth Link be at their true diſtance from the Chain's end; and then take the intermediate Links and parts with a Rod of 10 Links, divided into 100 parts.

Angles are taken with Rods of 5 and 10 Foot,

AND alſo laid down in all reſpects as with the Chain; but obſerve that one end of each Rod ſhould be ſloped off to an edge, like the Rod Gaugers uſe for taking the Diagonal Line of a Cask. Alſo that each Rod be nicely divided into Feet, and that the intermediate diſtances be eſtimated by a Foot Rule divided into 100 equal parts.

Angles taken with Rods are uſually about Gardens and Buildings, but are no ways fitting for large Plans.

As for the Chain, a *Surveyor* may with it for a ſhift, perform many Works, but not all; and this, at beſt, is both laborious and tedious.

The beſt Inſtruments for Surveying all manner of Lands both great and ſmall in all Caſes, are the *Theodolites* before mentioned.

If the *Surveyor* have only a Chain, and hath drawn his Plane, and would draw thereon a Meridian-line; he may do it thus; exactly at 12 a Clock mark the ſhadow of ſome upright Object, as the Corner of a Houſe, or ſome ſtraight Tree, or your Staff ſet upright; then plot this Line on your Plane, and it is a Meridian Line.

Or thus, in a Night when the *Pole Star* is to be ſeen; place your ſelf ſo, that your Eye, the *Pole Star* and ſome upright Object, as the Corner of a Houſe or ſtreight Tree, be in one ſtreight Line; then plot the Line from your Feet to the upright Object, and it will be a Meridian-line.

Indeed the *Pole Star* moves round the real Pole; but at ſo ſmall a diſtance from it, that in this Caſe the Variation may be rejected.

However you may obſerve that the *Pole-Star* is full North about the 20th Day of

March and *September* at 12
April and *October* at 2
May and *November* at 4
June and *December* at 6
July and *January* at 8
Auguſt and *February* at 10.

a Clock either Morning or Evening; always encreaſing nearly two Hours for every Month.

Therefore if the Obſervation is made about theſe times, the Variation will be very inconſiderable.

Alſo obſerve, that 5, 6 or 7 Hours before or after theſe times, if the pointers are to the {Eaſtward / Weſtward} of the Pole'; then the Variation by the Star is about 3 degrees and $\frac{1}{2}$ {Weſtward / Eaſtward} and this Variation is the greateſt.

CHAP. III.

Of the Chain.

FIrſt, provide a Staff juſt 6 Foot 7 Inches and $\frac{3}{10}$ long, which divide into 10 equal parts; and ſo will the whole be the length of 10 Links, and each part the length of one, and 10 times the length of this Staff the length of the whole Chain.

With this Staff examine the length of the Chain, and alſo of every 10 links; ſtretching it on level Ground the while, to ſuch a degree as you deſign to ſtretch it, when you meaſure with it.

Before you meaſure with it, provide 9 Arrows or ſmall Sticks each about two Foot long, and two ſtrait Staves about 5 Foot long each.

When you are about to meaſure with it, let him that leads the Chain take the 9 Arrows and one of the Staves; and he that follows it the other Staff.

Then the Follower ſtanding at the Station, let him direct the Leader to place his 5 Foot Staff at the Chain's end in the ſame right Line with the Stations; and then let the Leader take up the Staff, and in its place ſticking down one of the Arrows go on.

Now the Follower being come to the Arrow, let him direct the Leader to place his ſtaff as before.

And then let the Leader ſtanding at his ſtaff, look back towards the laſt ſtation, and he will ſee the ſtaves and the ſtation in one right Line, if they have directed right. But if they are not in one right line the leader muſt direct the Follower to place his ſtaff at the Chain's end in the ſame right line with the ſtation and the Leader's ſtaff.

And

And ſo, let each direct the other till the two ſtaves and the two ſtations are in one right line, and then muſt the Leader put down an Arrow in the place of his ſtaff, and go on: And the Follower take up the Arrow where he laſt ſtood, and go after him.

And let him thus proceed till they have meaſured to the ſtation, or till the Leader is nearer the ſtation than one Chain's length; and then will the Number of the whole Chains meaſured be expreſſed by the Number of the Arrows prickt down; which ſuppoſe 7.

Now let the Leader go on to the ſtation, and there hold the end of the Chain, and let the follower ſtretch the Chain as uſual; and then ſee, how many Links are contained between the laſt arrow and the ſtation; which may be readily counted by help of different bits of Braſs; or Curtain Rings, or other Marks fixt at the end of every tenth link: which links ſuppoſe to be 47.

Laſtly, enter in your Field-book the Chains and Links without any Diſtinction between them; and they will be 847; which imply either 847 links, or 8 chains 47 links.

But here we are to obſerve, that the links muſt always poſſeſs two places; as 8 Chains and 4 Links muſt be written 804; that is 8 chains and 4 links; 804 links, and 8 chains without any links, muſt be written 800, implying 8 chains, or 800 links.

It is neceſſary that the *Surveyor* ſhould enquire of his Aſſiſtants at the end of every meaſured length, how many arrows each hath; and if the Sum of the arrows are not nine, it is evident they have dropt or left behind thoſe that are wanting; and conſequently the laſt length meaſured is doubtful, and muſt be remeaſured before you proceed.

When you are come to the ſtation, if it be convenient to continue the length; let the Follower ſtand at the laſt arrow, and let the Leader go on with the Chain, and ſo place his ſtaff, that it and the two ſtations are in one right line; then in the place of the ſtaff put down an arrow, and go on; always directing himſelf to place his ſtaff, and conſequently his arrow by the two ſtations.

When you have continued your length, till you have nearly loſt ſight in the fartheſt ſtation, ſet up another ſtation-ſtaff in the place of the laſt arrow, and go on to continue by the two neareſt ſtations.

But withal take this Caution; that it is not ſafe to continue lengths very long, when the ſtations are near one another.

Laſtly, when your length is very great, having meaſured nine Chains, let the Leader go on and ſet his ſtaff down at the tenth; now let the Follower put his ſtaff in the place of the Leader's, and give the Leader the nine arrows, and then go on. But obſerve to enter in your Field-book theſe ten Chains, and never truſt to your Memory. And if your length conſiſts of ten Chains more, work as before, and enter 20 Chains: and ſo on.

CHAP.

CHAP. IV.

Of the Laying out of Lands.

WHEN any Number of Acres, Roods and Perches are to be laid out; it is convenient to reduce them to ſquare links; which may be done thus:

If the Roods are $\left\{\begin{matrix}1\\2\\3\end{matrix}\right\}$ add $\left\{\begin{matrix}40\\80\\120\end{matrix}\right\}$ to the Perches, and to the Sum annex 4 Cyphers. Divide this laſt by 16, and write the Quotient Figures if they be 5, after the Acres.

But when the Quotient Figures are but $\left\{\begin{matrix}4\\3\end{matrix}\right\}$ write $\left\{\begin{matrix}\text{one Cypher,}\\\text{two Cyphers}\end{matrix}\right\}$ after the Acres and then the Quotient Figures: And ſo will you have the ſquare links required.

A. R. P.

Ex. I. *Reduce* 7. 2. 24 *to ſquare Links.*

24
80

16)1040000(65000
80000
..

Anſwer 765000

A. R. P.

Ex. II. *Reduce* 7. 0. 11 *to ſquare Links.*

16)110000(6875
146
120
80
..

Anſwer 706875

A. R. P.

Ex. III. *Reduce* 7 0 01 *to ſquare Links.*

16)10000(625
40
80
..

Anſwer 700625

The Problems of laying out lands, as met with in practice, are in Number 3.

For

For, either the Partition-line is required to be parallel to ſome other line aſſigned, or to paſs through a point aſſigned in the Fence, or to paſs through ſome point aſſigned within the Land.

In the Solution of each of theſe I chuſe an arithmetical Approximation rather than a Geometrical Conſtruction; for Reaſons ſufficiently known to thoſe who have practiſed.

PROB. I. *Let it be required to cut off towards AB, Fig.* 10. 8 *Acres,* 3 *Rods* 18 *Perches by a Line drawn parallel to AB.*

Firſt, Draw parallel to AB a line CD by gueſs, and then caſt up the Content of the Figure CDHG, which ſuppoſe to be 772575

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ſquare links, which is leſs than 8 3 18, or 886250 ſquare links, by 113675 ſquare links, which ſhews that the Partition-line is more towards K.

Now divide the exceſs 113675, by 965, the length of CD in links, and at the diſtance of 118 links the Quotient, draw EF parallel to CD, and it will be ſufficiently near the Partition-line required.

But if by Curioſity you are led to correct the Variation; you may conceive C D, to be a Line given in Poſition, and 113675 ſquare links, to be the quantity to be cut off, and EF the Line drawn by gueſs.

But if the Line CD had cut off the quantity CDHG greater than that required, then the Partition-line had been more towards GH, whoſe Diſtance from C D, would be found as before, by dividing the Difference by the Length CD.

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PROB. II. *To cut off* 5 0 35 *towards L, Fig.* 11. *by a Line drawn from the Point* P.

A.. R. P.

Reduce the given quantity 5 0 35 to ſquare Links, and they will be 521875.

Then draw L V, forming the Triangle V L W, which being caſt up amounts to 3800 ſquare links, which is too little.

To the next Angle draw V M, forming the Triangle V L M, which being caſt up will be found to amount to 297632 ſquare links, which added to the Triangle V L W, you have 328432 ſquare links, the Content of the *Trapezium* V W L M; which is ſtill too little.

To the next Angle draw V P forming another Triangle, whoſe Content 403850 ſquare links added to 328432 the Content of the preceeding Figure, gives 732282 ſquare links, which is more than the required quantity by 210407 ſquare links; therefore the Partition line paſſes between P and M. Divide the Exceſs by 497, half

the length of VO the Perpendicular in links; and lay 423 the Quotient from P to N; and ſo ſhall V N be the true line of Partition.

A. R. P.

PROB. III. *To cut off* 7 3 13 *towards* B *from a Line paſſing by the Point A.* ſee Fig. 12.

It may be thus performed; conſider through which two ſides the Partition-line will paſs. Reduce the Figure to a *Trapezium*, ſtill retaining thoſe ſides. Which divide by a line through the aſſigned point A, as taught in the firſt Book.

But, becauſe this Method is tedious, and depends on the Concourſe of many lines; and tho' we ſhould uſe Numbers, we ſhould little mend the matter, and indeed is often impoſſible to be performed by one ſingle line, it may not be amiſs to ſhew how to do it by two lines.

From A to any two Angles H & B draw the lines AH, AB, forming the Triangle A H B, which being caſt up amounts to 338000 ſquare links leſs than the quantity required.

To the next Angle C draw AC forming the Triangle ABC, which being caſt up amounts to 322500 ſquare links, which added to the Triangle AHB gives 660500 ſquare links, which are ſtill leſs than the quantity required.

To the next Angle F draw A F, forming the Triangle ACF, whoſe Content 280800 ſquare links added to the preceeding Triangles AHB ABC gives 941300, which exceeds the quantity required by 158175 ſquare links; now divide this Exceſs 158175 by 292 half the length of the Perpendicular EL, and lay the Quotient 541 from F to D, and draw AD; and ſo will the lines HA AD be the Partition required.

It may not be improper, perhaps to add in this place, the manner of caſting up ſuch Fields as conſiſt of many ſmall Breaks in the Hedges; without reducing them to a multitude of Triangles. *e. g.*

Let Fig. 13, be ſuch a Field. Produce N M, ſome one of the longeſt ſides; then lay the edge of a ſtrait Ruler from M, one of the Angles at the end of N M, to G the next but one; holding the Ruler thus faſt, take with a pair of Compaſſes the diſtance from L to the Edge of the Ruler, and with this diſtance let one point of the Compaſſes move gently cloſe to the Ruler, while the other point traces out a Line parallel to it, and croſſes NM in Q. Now draw GQ, and it will reduce that ſide of the Figure, which was bounded by the two lines ML LG, to another bounded by GQ. one ſingle line only.

In like manner Q G being produced, and a Ruler laid from G to E, carry the diſtance of F from the Ruler parallel to it, till you croſs M G in K. Secondly, lay a Ruler from K to the next point D, and carry the diſtance of E, the laſt point ⊙, from the Ruler parallel to it, till you croſs MG in H. Thirdly, lay a Ruler from H to the next point C, and carry the diſtance of D the laſt point from it, parallel, till you croſs M G in I. Laſtly, Draw I C; and

and the ſide G C which conſiſted of the four lines GF FE ED DC, will be reduced to the ſide IC, conſiſting of one line only. And in like manner we might proceed if the lines were never ſo many.

And thus laying a Ruler from C P draw P O; and in like manner A Q. So will the ten ſided Figure be reduced to a four ſided one, and ſo then may be caſt up by one Multiplication only.

Provide a Plate of thin Braſs in form of an Arch of a Circle; near whoſe ends let there be drilled ſmall holes; thro' which ſtring it with a very fine Hair. Being thus provided; when a Hedge as GC bends in and out in ſeveral places, and thoſe Bends contain very ſmall ſpaces; lay the Hair over it length wiſe, ſo that the quantities cut off from the Figure thereby may be equal to thoſe added to it; and with your Protracting-pin near the ends of the Hair make two Marks, through which draw a ſtrait Line; and ſo will this irregular ſide be reduced to a regular one. And here we may obſerve that in very ſmall Bends, by the Eye we judge better than we can by the Compaſſes.

Laſtly, if Hedges conſiſt of large Curvatures (as in Fig. 14. 15.) Chuſe out ſuch points, and ſo many of them that right lines drawn from point to point, may vary the Quantity by ſuch Quantities only as may be rejected. And herein your Hair will be a ready Aſſiſtance.

CHAP. V.

The uſe of the Theodolite *exemplified in Surveying ſeveral Parcels of Land lying together.*

After a general Deſcription of Inſtruments and their Uſes; ſome practical Examples are neceſſary to illuſtrate and explain the particular Varieties which often occur.

The following Example I have handled in the ſame Method which I my ſelf practiſe.

The Inſtrument which I uſe is a *Theodolite* numbred on the Limb from the left to right; and in the Box (which is fixt to the Index) from the right to the left; the Eye being ſuppoſed in the Center.

The *Chain*, the *Off-ſet Staff*, the *Arrows*, &c. are as deſcribed in the third Chapter.

The Field-Book I divide into three Columns. The middlemoſt contains the ſeveral Lengths taken by the Chain. The outermoſt Columns contain the ſeveral *Off-ſets* and the Deſcription of the moſt remarkable Objects, which are to be met with in the Survey.

By

By the Mark ⊙, I denote a Station, by ✓ I denote an Angle, by *B* I denote a Bearing, by *Int.* I denote a cutting a Hedge by the Chain, by *ag.* I denote ſome remarkable Object on the farther ſide of the Hedge. Theſe Symbols I have uſed inſtead of Words, becauſe they conſtantly fall in the way; but other Objects which are more rarely met with I expreſs by Words.

Being thus provided, in the firſt Page of the Field-Book near the top I enter the Title of my Survey. Then having fixt my Inſtrument in ſome convenient place, as A to begin at, I enter in the middle Column ⊙ 1. denoting the firſt ſtation.

Here may be obſerved that I always chuſe to work in a Lane, as oft as Opportunity preſents.

My Inſtrument being planted at A, I ſend a ſtation ſtaff forwards in the Lane as far I can ſee diſtinctly; the farther the better (ſuppoſe to B^3). and when I work in the Land, I ſend a ſtation ſtaff to the next eminent Bend in the Hedge or even to the farther end of it, if the Line from the Inſtrument to the Staff be not too great a diſtance from the Hedge, ſo as to cauſe Off-ſets greater than a Chain or a Chain and a half or thereabouts. For Off-ſets taken too great, produce ſome Uncertainties.

Firſt then, I obſerve the Bearing of the line AB, thus, the Flower-de-luce in the Box being towards me, I direct the Sights to B^3, and then find the Needle cut 327°, which I enter in the middle Column under ⊙ 1. thus, *B* 327°.

The Obſervation being made of the Line's poſition, which I am about to meaſure, the next thing is to lay the Chain from this ſtation A in a right line towards the next ſtation B^3; which being done I let it lie, till I have entred the Occurrences in this Chain's length, *viz.* I meaſure the Diſtances of the Chain from the Brow of each Ditch, which I enter in the outſide Columns, that of the right Hand of the Chain in the right Hand Column, that on the left in the left Hand Column, and alſo the Names of the Perſons who own theſe Lands abutting; or if theſe Lands are ſome of thoſe which I am about to ſurvey, I enter the Names of them, and in all caſes expreſs to which Land the Hedge belongs.

Theſe Precepts I ſhall not repeat, though I ſhall ever make uſe of them, but if I uſe any other, I ſhall lay them down the firſt time I meet with them in this Example, but not afterwards.

Fitſt then, I enter 0 in the middle Column, and 20 in the right Hand one, and 20 in the left, denoting that at no diſtance, or at the Inſtrument, the Ditch on the right Hand is 20 links from the chain, and that on the left alſo 20. In the right hand column I write *William Wary's Land, Hedge to Wary*; and in the left, *Lord Titles Land, Hedge to Lord*; becauſe the Land and Hedge on the right is *Wary's*, and that on the left *my Lord's*.

Being

Being come to *a*, I am right againſt the South Hedge of *Hazle Spring*, and alſo of *Woodfield*, and there find the diſtance from the Ditch on the right hand to be 25, and on the left to be 20, and that afterwards the Hedge on the right hand belongs to *Hazle Spring*, and on the left to *Woodfield*. Therefore I enter in the middle Column 65, and in the right hand Column I enter 25, *ag.* Hedge on *Hazle Spring*, Hedge to Spring.; and in the left 20, *ag.* Hedge on *Woodfield*, Hedge to Field.

Here may be obſerved that I always meaſure theſe Off-ſets or Diſtances of the Chain from the Hedge (with my ten link Staff which I therefore call my *Off-ſet Staff*) perpendicular to the Chain, and ſo far till I come to that Brow of the Ditch, which is fartheſt from the Stem of the Hedge. And that here by the Brow of the Ditch I mean the determined Diſtance of five Links from the Stem of the Hedge. And in order to lay this ſtaff perpendicular to the Chain, it would be convenient to have two pieces at one end of it at right Angles, like the Squares uſed on a Drawing-board; and theſe pieces for Convenience in Carriage, may be made to fall into the Staff by Springs like a Claſp-knife.

Having entred my Obſervations in my firſt Length of my Chain, I obſerve what place of the Ground is exactly under the Centre of my Inſtrument, by dropping a Musket bullet; then I remove my Inſtrument, and in that place fix as upright as I can, a Station-ſtaff, and then proceed with the Chain.

And becauſe in the ſecond and third Lengths of the Chain I meet with no ſenſible Turns in the Hedge, nor other material Occurrences, I go on to lay it a fourth time, and there againſt 45 links I find a Bend in each Hedge; where on the right Hand the Brow of the Ditch is 50 links diſtant from the Chain, and on the left 40; therefore in the middle Column I enter 345 (denoting 3 chains 45 links) and in the right hand Column 50, and in the left 40.

And here may be obſerved that I take Off-ſets only at each end of ſuch parts of a Hedge as run very nearly ſtrait, omitting the intermediate parts; ſince when the Extreams of a right line are given, that right Line it ſelf is alſo given. So here, though the Diſtance of the Hedges from the Chain between *a* and *b* continually vary, yet I only take the Off-ſets at *a* and *b*, ſince theſe are ſufficient. But when the Hedge runs on with a continued but irregular Curvature, I take Off-ſets at every Chain or half Chains length or perhaps oftener, as the thing requires. But when the Curvature is regular, I take its Extremities by Off-ſets, and expreſs its Nature by a Sketch, in the outſide Columns figured.

In going on from *b* towards *B*, when I am come to *c*, the Chain touches the Brow of the left Hand Ditch, againſt 20; then I ask the hindmoſt Man how many Arrows he hath, he anſwers 5; then I enter in the middle Column 520 (denoting 5 chains 20 links) and in the left Hand Column 00, denoting that the Brow of the Ditch is at no diſtance from the Chain. The Chain ſtill lying againſt 40 links, I find a Bend in the right Hand Hedge; where the Ditch is diſtant from the Chain 50 links.

Now it may be obſerved that I frequently ask the Follower of the Chain, and alſo the Leader how many Arrows they have, eſpecially when I am about the off-ſet or other occurrence, partly to know the Number of the Chains, and partly to prevent the loſs of an Arrow; for this always raiſes a Doubt of the Length, and muſt be removed before we proceed; and leſt when a Stick is dropt another may be pickt up in its room, I always give my Arrows ſome Marks of Diſtinction.

If the Sum of the Arrows in both my Aſſiſtants Hands are leſs than nine, then the laſt Length muſt either be remeaſured, ſince it's doutful, or elſe the Surveyor muſt ſtep it, and thereby diſcover, which dropt it: And this with a little practice he will eaſily do by counting his Steps, and uſing himſelf to ſtep about the ſame diſtance each Step; and by looſing a Button of his Coat when he hath gone as many Steps (as by Experience he knows) carry him the Length of a Chain. And hence he may know exactly the Number of the Chains, though he cannot perhaps find exactly the odd Meaſure. But the Number of Chains is ſufficient, becauſe the Error by dropping Arrows always falls in whole Chains.

In like manner, at the Length of juſt 800, becauſe the Chain touches the right Hand Ditch, and is diſtant from the Bend in the left hand 40 Links; I enter in the middle Column 800, in the right hand Column 00, and in the left 40.

Then I continue on to my ſtation-ſtaff at B^3, which I find to be at the Length of 825, where becauſe there is no Bend in the Hedge, nor other material occurrence; I enter 825 in the middle Column, and under it I draw a Line, denoting that this Length, and all the occurrences therein are obſerved and entered in the Field-book.

Since I have endeavoured to be plain and eaſy in this firſt Length; ſo ſhall I in the following part of this Example, be as conciſe as I can, unleſs where I meet with Matter not before ſpoken of; referring the Reader rather to the Field-book and Explanations, than tiring him with Repetitions.

Being come to B^3, I there ſo plant my Inſtrument, by help of my Bullet, that its Center is directly over the Hole, which the Station-ſtaff ſtood in; and I ſend my Station ſtaff forwards, as far as I can conveniently ſee it, as to C.

Now with the beginning of the Degrees towards me, I direct the fixt Sights back to the Staff at A; and then ſcrew the Inſtrument faſt. And then with the Flower-de-luce towards me, I direct the Index to the Staff at C; and there find, that the end of the Index next me, cuts 202°. 15′, and the South end of the Needle points at 304°. 45′. Therefore I enter in the middle Column of my Field-book, O 2, and under it > 202°. 15′, and next under this *B* 304°. 45′; denoting that at the ſecond Station the Angle made is 202°. 15′, and the Bearing of the ſecond Length is 304°. 45′.

But

But before I proceed, I examine these Numbers thus: to the Bearing of the last station 327°, I add the constant Number 180, and and from the Sum 507°, I substract the present Bearing 304°. 15′; and find the Remainder 202°. 15′, exactly equal to the Angle.

Or else, to the Angle 202. 15, I add the present Bearing 304°, 15′; and from the Sum 507° substract the constant Number 180, so shall the Remainder 327° be the Bearing of the last Length exactly as taken at the last Station.

And this Operation I place in the outside Column against the same Angle and Bearing, to signifie that the Angle and Bearing have been compared and do agree.

But if these Numbers thus compared do not agree, the present Angle and Bearing must be examined and corrected; and if after such Examination they do not agree, there is an Error in the last Bearing, which may be taken again; thus,

The Instrument standing in the same place, I direct the Index, the Flower-de-luce being from me, to the last station staff at A; and then will the South end of the Needle point at the same Degrees which it did, when the Instrument stood at A, and the Index was directed to B[3].

Having thus taken, entered and examined the Angle and Bearing; I proceed with my Chain, and find the Lengths and Occurrences to be as you see them in the Field book.

Then fixing my Instrument, as before taught at C; I send my Station-staff forward to D, and observe, and enter and prove the Bearing and Angle at C; and then stretching my Chain towards D, I find at the Length of 250, a Gate on my right hand, and at 260 at the distance of 10 links the corner of *Hazle Spring*. Therefore in the middle Column I enter 250, and right against it in the right hand Column I write *Gate*; again in the middle Column I enter 260, and right against it in the right hand Column 10 *Corner*. And then proceed to the Station staff at D.

Having finisht the Length CD and fixt the Instrument at the 4th Station D; I do not go up the Lane towards E but turn off towards L; in order to close in *Hazel Spring* and *Spring Close*, always observing this Law, *viz.* Never to make a Tour greater than necessity requires, but always to close as often and soon as possible.

Therefore having sent a Staff to L; I observe, enter and prove the Angle and Bearing at D.

Here may be observed that when I came to K in the first length, the Hedge on the right hand belonged to *Woodfield*, and not to the Lane; and therefore I entred in the left hand Column, Hedge to Field; and since this note, the Hedge on the left hand hath continued to belong to the same *Woodfield*; therefore I have not repeated that Occurrence. But in going from D to L, at the Length of 15 links, I am against the corner of *Long Mead*, and 10 links distant from it, and then the hedge belongs to *Long Mead*. Therefore astar Q4. > 259° 20′, B 261° 20′,

10', I enter in the middle Column 15, and on the left hand 10 *Corner*, then on *Long Mead*, then *Hedge to Long Mead.*

But becauſe on the right hand we have ſtill *Hazle Spring*, and the Hedge is ſtill to the Spring, and becauſe theſe have been always on the left hand ſince I firſt enter'd them; I go on without any farther Remark till I meet with a different occurrence.

Being come to L, I obſerve, enter and prove the Bearing and Angle and then proceed to M. At M I obſerve and proceed in like manner to N. But at N, the ſeventh Station, inſtead of going on in the Lane, I proceed to cloſe in *Hazle Spring*, and therefore ſend a ſtation ſtaff to O in *Spring Cloſe.*

Therefore at the ſeventh ſtation N in the Lane, having obſerved, entred and prov'd the Angle M N O, and the Bearing of the Line N O. and directed the Chain from N towards O; I find the Chain cuts the Brow of the Ditch at 10 Links diſtant from N; therefore in the middle Column I enter 10 *Int.* denoting the Chains interſecting the hedge, and before I write in *Spring Cloſe*, denoting that the Land we are in is called *Spring Cloſe*, and in the right hand Column but the next Line I write *Hazle Spring*, and under this *Hedge to Spring*, denoting that the Land on our right hand is *Hazle Spring*, and that the hedge belongs to the ſame. Then I proceed to obſerve, meaſure and enter thoſe occurrences, as they are found in the Field-Book till I come to O.

At O, I obſerve, enter and prove, and proceed as uſual towards Q D; noting that at the length 720 the Chain did cut the hedge in the very corner of the Fence; and therefore enter in the middle Column 720 *Int.* and in the right hand Column 00 *Corner*, and then in the middle Column I write *in William Wary's Land*; and ſo proceed to Q.

Being come to Q, the ninth Station, I ſend a ſtation-ſtaff towards A; and then obſerve, enter and prove my Angle and Bearing; and ſo proceed with the Chain entering all occurrences, as in the Field-book, till coming to the length 830, I find my ſelf right againſt the corner of *Hazel Spring*, and 43 diſtant from it; which being entred as you ſee in the Field book, I write in the middle Column * *Cloſe Hazel-ſpring*, denoting that the Extremity of this Off-ſet co-incides with the firſt Off-ſet taken to *Hazel-ſpring.*

Having thus compleated *Hazel-ſpring*, I return to N, my ſtation in the Lane according to that general Law I always obſerve, of working in a Lane, and according to that Law of cloſing as oft as poſſible.

Now if I turn back the Leaves of my Field-book, I find the ſtation immediately before my coming into *Spring-Cloſe* was by Number the ſeventh. Therefore in my Field-book I enter ⊙ 7.

But here may be obſerved that when ſoever I deſign to return to the ſame ſtation; before I left it, I cut a Turf from the hole where the ſtaff ſtood, or leave ſome other Mark, whereby I may exactly find it again readily; and in the Filed-book to the Mark ⊙, I pre-

fix

fix the Letter *R*: by which and the other concomitant Notes I readily discover the number of the Station.

Having now planted my Instrument a second time at N, and sent a Staff forwards to R, I observe the Angle MNR made by the Line NR I am next about to measure, and the Line MN, that which I measured immediately before I came to N the first time.

And this I always make a constant Law, *viz.* To observe the Angle with that Line which was measured immediately before I came to the station, where I took the Angle the first time. So here I observe the Angle made with M N and not with any other as ON, and therefore in proving the Angle M N R, I use the Bearing of MN taken at M.

Now having taken, enter'd and prov'd the Angle MNR, and the Bearing of NR; I go on with the Chain towards R, entering the several occurrences as you find them in the Field-book.

Being come to R, the tenth Station, though my Design is to enclose *Spring Close*; yet because the last length continued strait forwards, will take the South hedge of *Long Mead*; in the middle Column I enter ⊙ 10, ∠180: and then direct the Leader of my Chain to lay it right forwards by help of the Stations R and N. And accordingly I enter the occurrences of that Length, as you see in the Field Book.

This finisht I return to R, and sending a Station staff to S; I enter again ⊙ 10 and the Angle and Bearing at R; and so proceed to S.

And then from S to T; and so from T the 12th Station to P, enclosing *Spring Close*.

Spring Close being finished, I return to my 4th station at D. And then send a Station staff forwards to E; and then under ⊙ 4, observe and enter the Bearing of D E, and the Angle C D E; and then by the Bearing of CD, taken at the Station C immediately before I came to D, prove the Angle CDE; and proceed with the Chain entering all occurrences as usual.

Being come to E; I send the station to F, in order to close in *Woodfield*. Now after I have observed and entred the Angle and Bearing at the thirteenth station E, when I come to prove them; I find by adding 180° to 353°. 15′, the Bearing of the Line which brought me to this station; and when from the sum 533°. 15′ I have substracted 82° the present Bearing, I find the Remainder to be 451°. 15′, a Number greater than 360. Now as oft as this happens I lessen this Number by 360 degrees, and so will the Remainder be as in this Example 91°. 15′ the present Angle exactly.

Then entring the occurrences, I proceed to F, and in like manner from F to G, from G to H, from H to I, and then from I the seventeenth station to K thereby enclosing *Woodfield*.

This done, I return to E, and there because I can continue my Length DE, right forwards conveniently I enter ⊙ 13. ∠ 180°. 00, and then go on to V.

And then entring Angles, Bearings and other Occurrences; I proceed from V to W, and from W to X the 20th ſtation.

Being come to X, and having entred ∠234°. 20′ and *B* 307°. 40′, then after I have added 180°. 00′ to the laſt Bearing 2° 00′, I find the Sum 182. 00, is leſs than 307° 40′ the preſent Bearing; In ſuch Caſes I always add 360 to the Sum 182 and then from the Reſult taking the preſent Bearing 307°. 40′, the Remainder will be, as in this Example 234° 20′, the preſent Angle.

Then I proceed to Y, and from Y to Z.

Being come to Z, the 22d Station, in order to encloſe *Long Mead*, I go off to α, from α to β, from β to γ; where becauſe the ſeveral Bends of the River cannot ſo commodiouſly be taken without it, from γ I go off to δ; and then from γ to ε, from ε to ζ, from ζ to η, and from η the 28th ſtation to θ; thereby encloſing *Long Mead*. And then return to Z.

Being come to Z, I find it convenient to continue my length ſtrait forwards, and therefore under ⊙ 22, I write ∠180, and ſo go on to κ, from κ to λ, from λ to π; and then in order to encloſe *Butts Cloſe*, I go off from π, the 31ſt ſtation to ρ, and ρ to σ.

Then returning to π, I go on to A^2 the 33d ſtation, and then in order to cloſe the *Home Cloſe*, I go off to B^2, and ſo then to C^2, and D^1.

Returning then to A^2, I go on to E^2, from E^2 to F^2, from F^2 to G^2, and from G^2 to H^2, the 41ſt ſtation.

Being come to H^2, in order to cloſe in *Mottle Mead*, I go of to I^2 from I^2 to K^2, from K^1 to L^1, the 44th Poſition, and from L^2 to M^2, and ſo is *Mottle Mead* finiſhed.

Then in order to encloſe *Hazle Wood* I go from L^2 to N^2, from N^2 to the Angle at F, and ſo is *Hazle Wood* finiſhed.

Then I return to H^2 the 39th ſtation, and thence go to O^2, and from O^2 to P^1 the 45th ſtation.

And now in order to cloſe in *Hazle Field*, I go from P^2 to Q^2, and from Q^2 to T^2.

Which being done, I go from P^2 to R^2, and from R^2 to S^1; and ſo the whole is finiſhed, as you find it in the Field Book, and as far as relates to the Field Work.

It remains to ſhew how this Work may be plotted without any regard to the Memory; nay, though it were ſurvey'd by one Perſon how it may be plotted by another who never ſaw the Land; provided that the Perſon who ſurvey'd it hath ſtrictly obſerved the Laws here laid down. And I do affirm, that any Method of keeping a Field-book which lays a Burthen on the Memory, or by which a Perſon remote from the Land, cannot plot it, is imperfect and ought not to be practiſed.

CHAP.

CHAP. VI.

To protract the Obſervations contained in the preceeding Field-Book.

FIrſt, I draw parallel right Lines, as thoſe in the Scheme markt N S, repreſenting Meridians or North and South Lines, at a Diſtance from one another not exceeding the breadth of the Diametrical part of the *Protractor*.

Then picking out ſome convenient Place to repreſent the firſt ſtation as A; my Field-book being open before me, I lay the Center of the *Protractor* on the Point A, and the Diameter parallel to the Lines N S, and the beginning of the Degrees downwards, becauſe the Bearing is more than 180; then againſt 327 degrees I make a Mark with my *Protracting Pin*, to which I draw an obſcure Line from A, repreſenting the Chain-line from the ſtation A to the ſtation B.

Then to this obſcure Line I lay the Edge of my *Plotting Scale*, the beginning of the Diviſions coinciding with A, and encreaſing towards the next ſtation B, and becauſe the Off-ſets in the firſt length are taken at the Diſtances 65, 345, 520, 540, 800, 825; therefore againſt theſe Numbers on the Scale I make Marks in the obſcure Line cloſe to the Edge of the Scale.

This done, I turn my Scale perpendicular to the obſcure Line, and apply it ſucceſſively to theſe ſeveral Points, and there prick off the lengths of the ſeveral Off-ſets on their reſpective ſides of the obſcure Line; ſo at A, I prick off 20 on the right hand and 20 on the left; at the length 65 which is the next point, I prick off 25 on the right hand and 20 on the left; and at the next point which is at the diſtance 345, I prick off 50 on the right hand, and 40 on the left; at the fourth point, which is at the diſtance 520, I prick off 00 to the left hand; at the fifth Point, which is at the diſtance 540, I prick off 50 to the right hand; at the next point which is at the diſtance 800, I prick off 00 to the right hand, and 40 to the left; at the laſt point, becauſe no Off-ſet was taken, I lay none down.

And now if Lines are drawn from point to point on each ſide of the obſcure line, they will repreſent the Fences as was required. But when the Off-ſet is 00, as in the fourth and ſixth Diſtances, thoſe points, to prevent being overlook'd, ſhould be mark'd with a black lead Pencil, or ſomething elſe which may be eaſily rub'd out again.

At the ſecond Diſtance, where we were againſt the South Fences of *Woodfield* and *Hazel Spring*, with a black lead Pencil draw two ſhort lines, cutting the Lane, to denote that the South Fences come up to the Lane, and will hereafter be of uſe in cloſing theſe Plots.

Having

Having thus finiſh'd my firſt length, I produce it, if occaſion require from B, both ways, till it is as long each way as the *Radius* of the *Protractor*. Then I place the Center of the *Protractor* on B, and thereon turn it about, becauſe the Degrees of the next Angle are more than 180, till the beginning of the Degrees of the *Protractor* are contrary to the laſt ſtation A, and the Diameter coincident with A B. Then cloſe to the edge of the *Protractor* right againſt 202. 15′ I make a Mark with my *Protracting Pin*, and to it from B draw an obſcure line repreſenting the Chain line from B to C.

Then I turn the *Protractor* about, the Center ſtill coinciding with B, and becauſe the Bearing is more than 180, the beginning of the Degrees towards S. and the Diameter parallel to the Meridians; and then if you have truly wrought, the line BC before drawn will meet the Limb of the *Protractor* againſt 304°. 15′, the bearing of the line BC.

But if it doth not, the line B C is not in its true Poſition, and muſt be corrected before you proceed.

Or thus, the Center of the *Protractor* coinciding with B, I turn it about till the beginning of the Degrees is towards S. becauſe the bearing is greater than 180, and till the Diameter lies parallel to the Meridians; and then cloſe to the edge of the *Protractor*, with my *Protracting Pin*, I make a Mark againſt 304°. 15′, the bearing of the line DC, and to it from B draw a ſtrait line repreſenting the ſtrait line BC. Then turning the *Protractor* about on the Center C, and becauſe the Angle there taken was of 202°. 15′, more than 180, I turn the beginning of the Degrees of the *Protractor* contrary to the laſt ſtation A, and the Diameter to agree with AB; and then will BC meet the limb of the *Protractor* againſt 202°, 15′, if the Bearing is truly laid down.

And thus the Plot may be laid down by the Bearings and examined by the Angles.

Then to this obſcure Line, I apply the edge of my *Plotting Scale*, the beginnings of the Diviſions coinciding with the preſent ſtation B, and the Numbers encreaſing towards the next C; and then cloſe to the edge thereof againſt 240, 250, the lengths where the Off-ſets were taken, I make Marks with my Protracting-pin. This done, I turn my Scale perpendicular to the obſcure line, and at 240, I prick off 15 to the left Hand, and againſt 250 which gives the point C, I prick off 10 to the right Hand, as the Field-book directs. Now continuing the Fences to theſe Off-ſets, I ſhall have finiſht the ſecond length from B to C.

The ſecond length thus finiſht, I produce it, if occaſion require, from C, both ways, till the length each way be at leaſt equal to the *Radius* of the *Protractor*. Then I place the Center of the *Protractor* on C, and becauſe the Degrees of the Angle at C, are leſs than 180, I lay the beginning of the Degrees of the *Protractor* towards B, the laſt ſtation, and the Diameter on B C. Then cloſe to the edge of the *Protractor*, with my *Protracting Pin*, I make a Mark againſt

144°.

140°. 45′, the quantity of the Angle at C, and to it draw an obſcure right line from C, repreſenting the line from C to D.

Then turn the *Protractor* about, its Center ſtill coinciding with C, becauſe the bearing is more than 180, the beginning of the Degrees towards S. and the Diameter parallel to the Meridians, and then if you have workt truly, the line CD before drawn will meet with the Limb of the *Protractor* againſt 340°. 30′, the bearing of the line CD.

But if not, the line CD is not in its true Poſition, and muſt be corrected before you proceed.

From the laying down theſe two Angles and Bearings, it appears how Errors, often happening in Practiſe, may be prevented.

The general Laws I obſerve herein are three: *viz.*

1. I lay the Diameter of the *Protractor* on that line which brought me to the preſent ſtation, where the Angle, about to be laid down, was taken.

2. I lay the beginning of the Degrees of the *Protractor* towards the laſt ſtation, when the Angle is leſs than 180 Degrees, but the contrary way, when the Angle is more.

3. In laying down or examining the Bearing, I lay the beginning of the Degrees of the *Protractor* Northwards when they are fewer than 180; but Southwards, when more.

In like manner I lay down and examine the Angles and Bearings taken at D, L, M, N, O, Q, the *4th, 5th, 6th, 7th, 8th, 9th* ſtations; and alſo the correſponding lengths and occurrences. But in the laſt length QA, having at the length 830 laid off an Off-ſet of 43, it gives exactly that corner of *Hazle-ſpring*, which was noted down in the firſt length in the Lane; which proves that the Angles and Lengths encloſing *Hazle-ſpring* are truly laid down. But if the Extremity of the laſt Off-ſet in the length Q A doth not coincide with the Extremity of the ſecond Off-ſet A *B*, both denoting the South-Weſt Corner of *Hazle-ſpring*; the Lengths and Angles deſigned to encloſe the ſame *Hazle ſpring* are not truly laid down; and therefore muſt be examined and corrected before you proceed.

Now ⊙7, being markt with 7, a Number not greater than 9, the Number of the laſt ſtation, being the next Work noted in my Field-book; I return to ⊙7 in my Draught and there with M N, the line which I meaſured immediately before I came to N, I make the Angle MNR 162°. 45′, and the bearing of NR 274°. 45′, as noted in the Field-book, and then proceed to lay down the Off-ſets and other Occurrences at their proper Lengths and Diſtances, as noted in the Field-book.

Having finiſhed N R; I find next following in my Field-book ⊙ 10, which becauſe it is greater than 8, the Number which immediately follows 7, the Number of the laſt ſtation; and becauſe I find no ſtation already laid down, markt with a Number ſo great as 10, and therefore conclude that the ſtation R, where I now am is to be numbred 10; and from thence proceed to lay down and examine the Angle and Bearing at R, as uſual.

The Laws I obſerve in theſe Caſes are,

1. To number with black Lead all the ſtations I have already laid down in my Draught; and alſo to expreſs thoſe Numbers ſucceſſively after one another in a Piece of waſte Paper; which I examine, as oft as I pleaſe.

2. If I come to a ſtation whoſe Number doth not immediately ſucceed the Number of the laſt ſtation; but is greater than the greateſt of thoſe Numbers noted in my waſte Paper by an Unite; then at the ſtation now arrived at, I lay down and examine the Bearing and Angle with the line I meaſured immediately before I came to this ſtation. And this ſtation I number as denoted in my Field-book.

3. If I come to a ſtation, whoſe Number doth not immediately ſucceed the Number of the laſt ſtation; but is greater than the greateſt of thoſe Numbers noted in my waſte Paper by more than an Unit; then ſome Omiſſion hath aroſe in my waſte Paper, and muſt be rectified before I proceed.

4. and laſtly, If I come to a ſtation whoſe Number is already entred in my waſte Paper; then I return to that ſtation in my Draught, and there lay down and examine the Bearing and Angle with the Line meaſured immediately before I came to this ſtation the firſt time.

Now the next Obſervation I meet with in my Field-book is again ⊙ 10; Therefore again at ⊙ 10. I lay down and examine an Angle and Bearing as noted in the Field-book, and then proceed to lay down the Lengths and Off-ſets of the Line RS, as I find in my Field-book.

Being come to S, I proceed to T, and from T to P, there cloſing with the Extremity of the Off-ſet at P. coinciding with the South Weſt Corner of *Spring Cloſe*, and the South Eaſt Corner of *Hazle-ſpring*.

This done, I find next in my Field-book ⊙ 04; therefore I return to ⊙ 4, and there proceed as my Field-book directs, till I come to ſtation 13; and becauſe this is a Number greater by an Unit than 12, the Number noted in my waſte Paper; I number it 13, and then proceed

Appendix Plate 1.

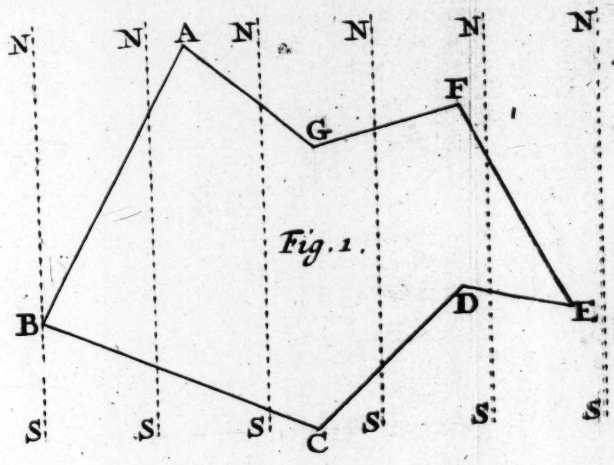

Fig. 1.

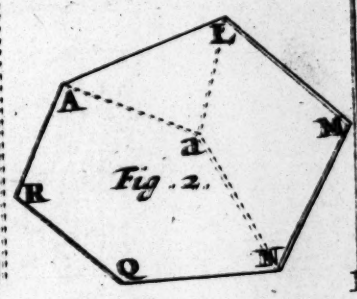

Fig. 2.

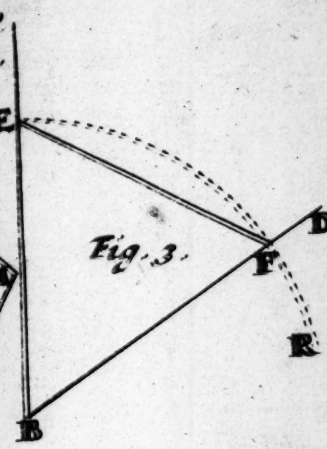

Fig. 3.

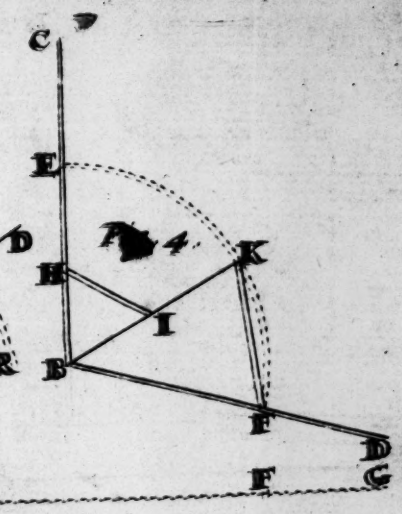

Fig. 4.

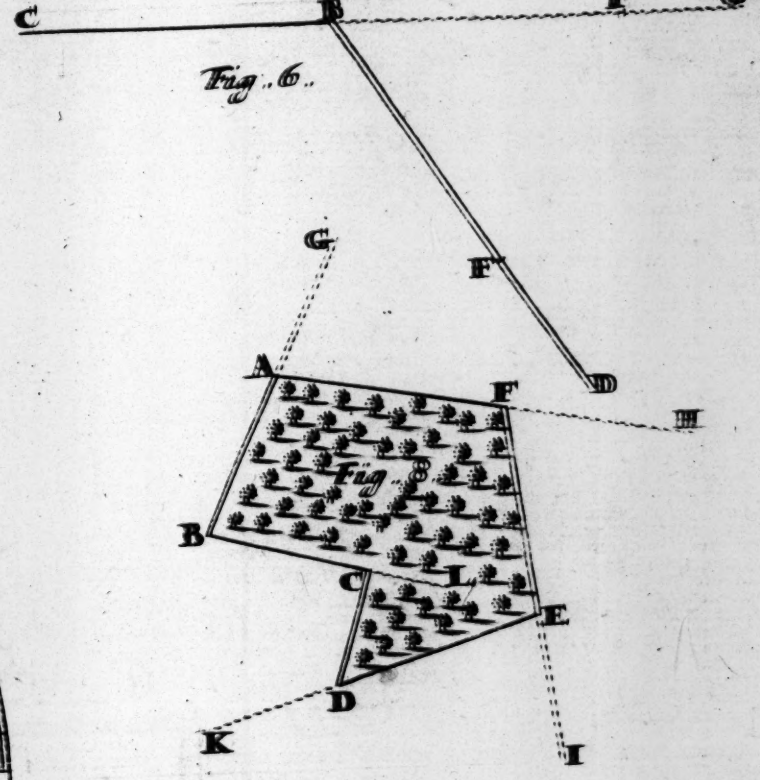

Fig. 6.

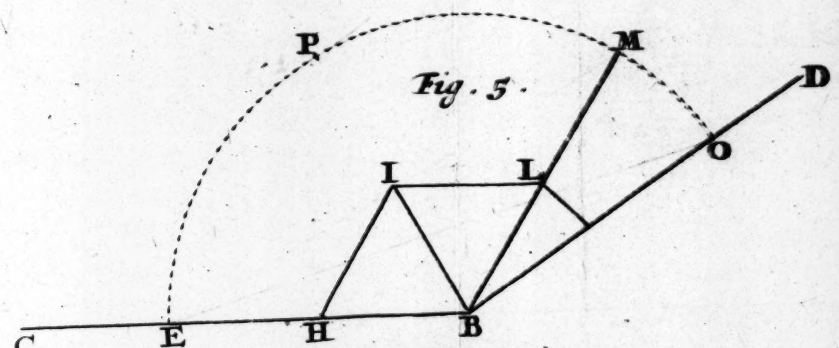

Fig. 5.

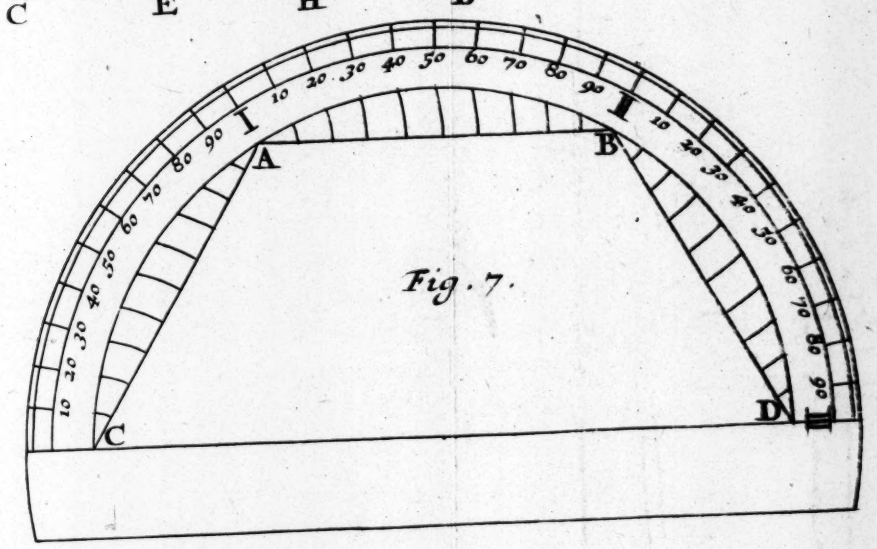

Fig. 7.

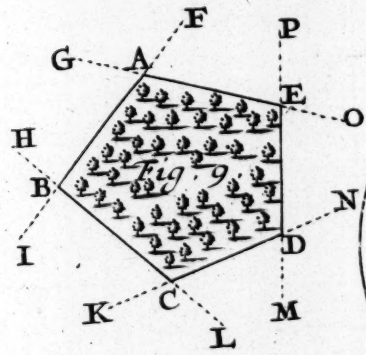

Fig. 9.

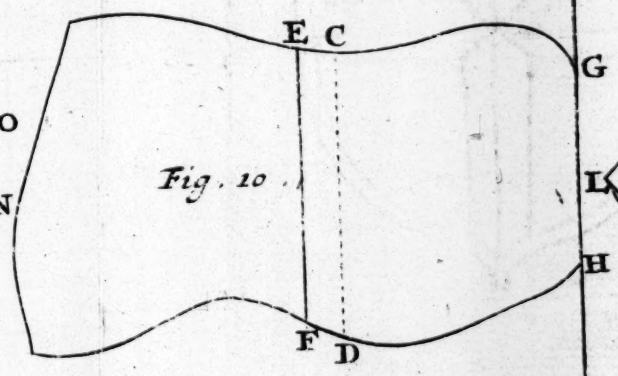

Fig. 10.

Fig. 11.

Fig. 12.

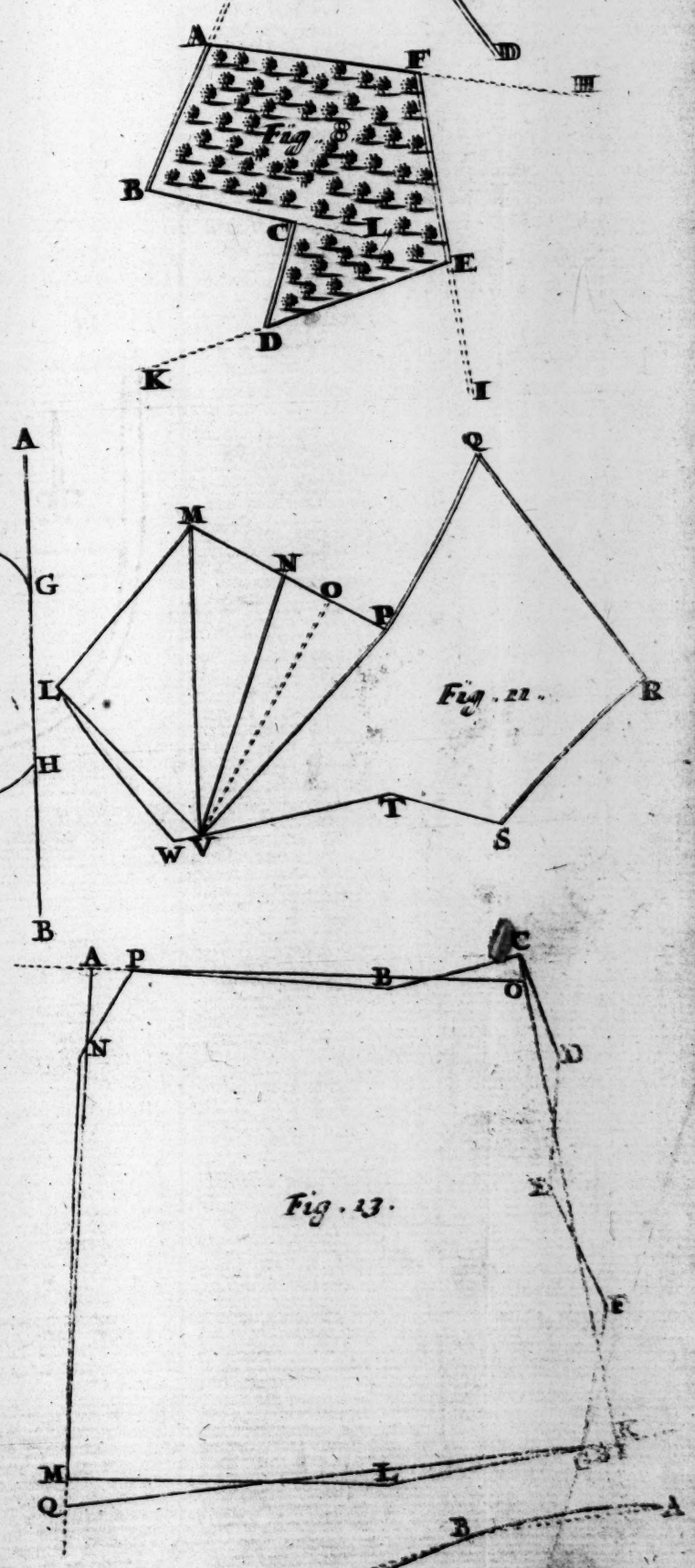

Fig. 13.

Fig. 14.

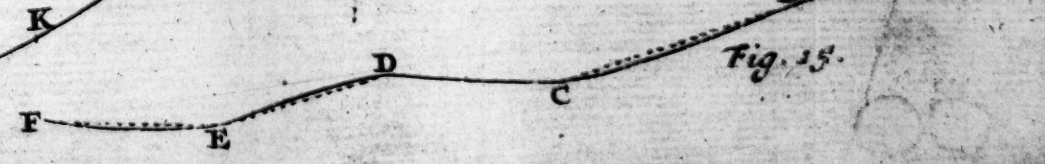

Fig. 15.

Roughton Common

Mottle Mead

Home Clofe

Butts Clofe

Hazle Field

Hazle Wood

Long Mead

Walter's Mead

Land

Titles

Wood Close

Common Mead

Lord

Thomas

Cole

The

Wood Field

Hazle Spring

Spring Close

Appendix Plate 2.

Wm. Wany's Land

ceed as my Field-book directs to F, G, H, I, and K, there closing in *Woodfield* by the Extremity of the Off-sets there laid down.

This done, I next find ⊙13, and therefore because already entred in my waste Paper; I return to ⊙ 13 in n Draught. And then proceed as before shewn, till I have plotted all the Occurrences mentioned in my Field-book; but the remaining part hereof I leave for the Exercise of the Reader.

I think I need not detain the Reader with the manner of transferring the Draught to his Velom; of drawing a Scale and a Compass, ever allowing the Variation of the Needle; of entring the Contents of each piece; and the Ornaments to be met with in other Parts of this, and every other Treatise of Surveying.

I shall only add that the Representation of the Hedges ought to be laid down on the same sides of the Fences, that they are in the Land; and to be broke off where there are to be the Representations of Gates, *&c.*

That there ought to be imaginary lines, both Vertical and Horizontal, denoted by Letters placed at the top and bottom, and also on the sides, to be referred to by the Table of References; for the ready finding any Field or parcel of Land therein contained.

Lastly, I shall in this place only add, that in all Performances of this kind, Errors for the most part arise from the Defects of instruments; in the Framing, Dividing and Contriving.

Therefore I think it proper to say, that I have seen a *Theodolite*, made by Mr. SISSON, *Mathematical Instrument Maker*, at the Corner of *Beaufort-Buildings* in the *Strand*, for Accuracy and Dispatch, fitter for a Surveyor than any other I have yet seen.

Now followeth the Field-Book.

Obſervations and Dimenſions of Lands lying in the Pariſh of ---- in the County of ---- part of the Eſtate of ----

February *the* 2*d.* 1720.

Beginning at the Lane leading from Hardly *to* Roughton.

		⊙ 1	
		° ′	
		B 327 00	
On Lord Title	20	0	20 On *William Wary*
Hedge to Lord			*Hedge to Wary*
ag. Hedge	20	65	25 *ag. Hedge*
On *Woodfield*			On *Hazle-ſpring*
Hedge to Field			*Hedge to Spring*
	40	345	50
	00	520	
		540	50
	40	800	00
		825	
° ′		⊙ 2	
327. 00		° ′	
180 00		< 202. 45	
507. 00		B 304. 45	
304. 15			
202. 45			
	15	240	
		250	10
304. 15		⊙ 3	
180		° ′	
484. 15		> 143. 45	
340. 30		B 340. 30	
143. 45		250	Gate
		260	10 *Corner*
	20	270	
340. 30		R ⊙ 4	
180		° ′	
520. 30		> 259. 20	
261. 10		B 261. 10	
259. 20			
Corner 10		15	
On *Long Mead*			
Hedge to Long Mead			
	15	220	
		⊙ 5	

	⊙ 5	
	° ′	
	▽ 156. 50	
	B 284. 20	
10	165	10
	⊙ 6	
	° ′	
	▷ 206. 50	
	B 257. 30	
10	230	10 *againſt Hedge*
		On Spring Cloſe
		Hedge to Spring Cloſe
	240	
	R ⊙ 7	
	° ′	
	◁ 264 30	
	B 173. 00	
	10 *Int.*	
In	*Spring*	*Cloſe*
		On *Hazle Spring*
		Hedge to Spring
	135	07
	245	15
	⊙ 8	
	° ′	
	◁ 202. 15	
	B 150. 45	
	154	18
	335	50
	550	35
	720 *Int.*	00 *Corner,*
In William	*Wary's*	*Land*
	825	
	⊙ 9	
	° ′	
	▷ 240. 00	
	B 90. 45	
	90	20
	510	05
	640	70
	755	15
	830	43 *Corner*
		Cloſe Hazle-ſpring
	⊙ 7	
	° ′	
	◁ 162. 45	
	B 274. 45	

261. 10
180
441. 10
284. 20
156. 50

284. 20
180
464. 20
257. 50
206. 50

257. 30
180
437. 30
173
264. 30

° ′
173. 00
180
353. 00
150 45
202. 15

150. 45
180
330. 45
90. 45
240. 00

taken from ⊙ 6
257, 30
180
437. 30
274. 45
162. 45

		40	*Gate*
	15	230	05
	50	230	
	35	260	
		350	10 *ag. Hedge and Corner of Spring-close*
	R	⊙ 10 ° '	
		V 180. 00	
		B 274. 45	
		0	On *Tho. Coles*
	30	60	
	20	100	20
	00	160	40
274. 45		⊙ 10 ° '	
180			
454. 45		V 246. 25	
208. 20		*B* 208. 20	
246. 25		10 *Int.*	
	In *Tho.*	*Coles*	*Land*
			Hedge to Spring Close
		300	100
		340	10
		370	
208. 20		⊙ 11 ° '	
180			
388. 20		V 208 20	
180		*B* 180. 00	
208. 20		00	18
		630	15 *Corner*
		680	
180. 00		⊙ 12 ° '	
180. 00			
360. 00		V 275.00	
85. 00		*B* 85. 00	
275. 00		20	*Corner on Spring-close*
			Hedge to Spring Close
		400	00
		870	20 *Corner*
taken from	⊙ 3		*Close-spring-close*
	° '	⊙ 4 ° '	
340 30			
180		V 167. 15	
520. 30			
353. 15			
161. 15		*B* 353. 15	
On *Woodfield*		10	10 *Corner of Long Mead*
			Hedge to Long Mead
	Gate 20	440	00

	R		
353° 15		⊙ 13	
180		∠ 91° 15′	
533. 15		*B* 82 00	
82. 00		20) *Int.*	
451. 15			In *Woodfield*
360		20	15 *Corner of Hazle-*
91. 15			*(Wood*
			Hedge to Wood
		550	15
		⊙ 14	
82° 00′		∠ 99° 00′	
180		*B* 163 00	
262		00	10 Gate
163			On *Wood-Close*
99			*Hedge to Woodfield*
		550	30
		⊙ 15	
163° 00′		∠ 249.45	
180		*B* 93. 15	
343			
93. 15		35	00 *Corner*
249. 45		430	130
		600	100
		610	50 *ag. Hedge*
			and corner of Woodfield
			On Lord Titles Land
			Hedge to Title
		835	10 *Corner*
93° 15′		⊙ 16	
180		° ′	
273. 15		∠ 77 35	
195. 40		*B* 195 40	
77. 35		00	00
		320	210
		500	00
		650	135 *corner*
		742	
195° 40′		⊙ 17	
180		∠ 129. 10	
375. 40		*B* 246. 30	
246. 30		00	15
129. 10		610	15 *corner*

		⊙ 13	
		∠ 180° 00	
		B 353.15	
ag. Hedge	20	20	
On Hazle Wood			
Hedge to Wood			
	25	140	00
		⊙ 18	
353.115		∠ 182°45'	
180.		B 350 30	
533. 15			
350. 30			
182. 45			
	10	360	20
	10	445	20
		⊙ 19	
350° 30'		∠ 168 30	
180		B 2. 00	
530. 30			
2.00			
528, 30			
360			
168. 30			
	00	100	20
	25	255	05
	25	350	00
	15	440	10
	10	520	20
	30	595	30
	30	663	70
		⊙ 20	
2° 00'			
180		∠ 234 20	
182. 00		B 307. 40	
360			
542. 00			
307. 40			
234. 20			
	Gate 75	60	
	30	170	
ag Hedge	20	215	00
On Buts-close			
Hedge to Close			
	00	450	20
		⊙ 21	
307° 40'		∠ 200. 40	
180		B 287. 00	
487.40			
287. 00			
200. 40			
	20	150	
	20	260	
	75	275	
		380	Gate
	70	400	00 ag. Hedge and corner of Long Mead
			On Walters Meadow
	25	510	

		R ⊙ 22	
° ′		° ′	
287. 00		⊲ 280 40	
180		*B* 186. 20	
467. 00		10 *Int.*	
186. 20			*In Walters Meadow*
280. 40		27	110 *Corner*
			On Long Mead
			Hedge to Long Mead
		360	15
		540	190
		735	10
		⊙ 23	
° ′		° ′	
186. 20		⊲ 200. 05	
180		*B* 166. 15	
306. 20			
166. 15		10 *Int.*	
200. 05			*In Long Mead*
Corner	10	20	
On Trout Beck			
	00	50	
	10	150	
	10	235	
		245	
166. 15		⊙ 24	
180			
346. 15		° ′	
11		⊲ 235 15	
235. 15		*B* 111. 00	
	10	40	
	20	105	
	00	255	
	25	345	
		460	
111. 00		⊙ 25	
180			
291		⊲ 61. 40	
229 20		*B* 229. 20	
61. 40	30	80	30
	30	120	
		150	35
	25	160	
		170	50
	10	200	40
111. 00		⊙ 25	
180			
261		° ′	
192 30		⊲ 128. 30	
128. 30		*B* 162. 30	
	15	145	
	150	190	

	10	430
	30	545
162° 30′		585
180		⊙ 26
342. 30		° ′
251. 30		V 91. 00
91		B 251. 30
		70
	45	175
	00	270
251. 30		⊙ 27
180		° ′
431. 30		V 141. 00
290. 30		B 290. 30
141. 00		
	67	205
	70	280
	15	360
		⊙ 28
290. 30		° ′
180.		V 291. 00
470. 30		B 179. 30
179. 30		
291. 00		
	10	00
On Tho. Cole Hedge to Cole		
	10	150
	20	300
	10	400
	10	510
		⊙ 22
		V 180° 00′
		B 186. 20
	In	*Roughton* *Common*
	Corner 00	30
		65
287°. 00′		⊙ 29
180		° ′
467		V 104 50
2. 10		B 2. 10
464. 50		
360		
104. 50		
On Butts Close		
	86	230
	00	480
	65	635
		⊙ 30
		V 89° 00′
		B 93. 10
		65 *Int.*
	In	*Butts Close*
		On Roughton Common
		100 65
		350 100

	750	100
	835	15
R	⊙ 31	
	∠100°00′	
	B 167. 10	
	0	20 *On Home-close*
		Hedge to Home-close
167°. 10′	590	15
180 00	⊙ 32	
347. 10	∠ 126°40′	
220. 30	B 220. 30	
126. 40	0	10
	85	10 *ag. Hedge*
		On Hazle-Wood
		Hedge to Wood
	415	10
	⊙ 31	
	∠180.00	
	B 93. 10	
	20 *int.*	*Gate*
	In Home	*Close*
		On Roughton-common
	195	30
	195	75
	750	10
R	⊙ 33	
93° 10	∠ 92°.40	
180	B 180. 30	
273. 10	00	10 *On Mottle Mead*
180.30		*Hedge to Home-close*
92. 40	625	15 *ag. Hedge*
		On Hazle Wood,
		Hedge to Wood
	735	20
180° 30′	⊙ 34	
180	∠ 122°10′	
360. 30	B 238. 20	
238. 20	00	10
122. 10	310	10
	⊙ 35	
238° 20′	∠ 109° 50′	
180	B 308. 30	
418. 20	00	10
308. 30	485	10
109. 50		

93° 10		⊙ 33	
180		▽ 171. 10′	
273. 10		*B* 102.	
102. 00		10 *Int.*	
171. 10		*In Mottle*	*Mead On Roughton Common*
		300	25
		315	
102° 00		⊙ 36	
180		▽ 200 00′	
282. 00		*B* 82. 00	
82.		70	65
200		150	10
		380	60
		600	15
		770	15
		808	10
82° 00′		⊙ 37	
180		▽ 136 30	
262. 00		*B* 125. 30′	
125. 30		00	15
136. 30		100	30
		260	30 *ag. Hedge*
125° 30		⊙ 38	
180		▽ 103 40′	
305. 30		*B* 201. 50	
201. 50		00	*On Lord Titles Land Hedge to Lord*
103. 40		255	60
		270	
201° 50′	*R*	⊙ 39	
180		▽ 102 30′	
381. 50		*B* 279. 20	
279. 20		00	30 *On Hazle Field Hedge to Mottle-*
102. 30		295	35 *(Mead*
		605	15 *Corner*
		620	
279. 20		⊙ 40	
180		▽ 282 05′	
459. 20		*B* 177° 15	
177. 15			
282. 05		370	10
177. 15		⊙ 41	
180		▽ 85° 25′	
357. 15		*B* 271. 50	
271. 50		00	15
85. 25		235	15

	R	⊙ 42	
		V 180° 00′	
		B 271. 50	
		20	15 *ag. Hedge*
			On Hazle Wood
			Hedge to Hazlewood
		375	15
271. 50		⊙ 42	
180		V 268° 50′	
451. 50		B 183. 00	
183. 00		15 *Int.*	
268. 50			
	In	*Hazle*	*Field*
On Hazle Wood			
Hedge to Wood			
	25	375	
	Corner 10	760	
		790	
183° 00′		⊙ 43	
180		V 153 30′	
363		B 209. 30	
209. 30	270	230	
153. 30	*Corner* 00	445 *Int.*	
	In	*Wood*	*Close*
	25	650	
Corner of	30	860	
Hazle Wood			
and Woodfield			
201° 50′		⊙ 39	
180		V 196. 35′	
381. 50		B 185. 15	
185. 15		30	20 *Corner*
196. 35		30 *Int.*	
			On Lord Titles Land
			Hedge to Lora
		400	165
		365	100
		1100	10
185. 15			
180		⊙ 44	
365. 15		V 193° 45′	
171. 30		B 171. 30	
193. 45		200	110
		345	30
		440	70
		520	20

171. 30	R	⊙ 45	
180		▽ 81° 00′	
351. 30		B 270. 30	
270. 30			
81			
		15	45 *On Woodclose*
			Hedge to Woodclose
		100	65
		340	95
		650	75
		740	80
		990	13
		46	
270. 30′		△ 112° 30′	
180		B 338. 00	
450. 30			
338. 00			
112. 30			
		00	10
		200	15 *ag. Hedge*
			On Hazlewood
		⊙ 45	
		▽ 180 00′	
		B 171. 30	
		15	10 *Corner*
		35 *Int.*	*On Lord Titles Land*
			Hedge to Title
		255	30
171° 30′		300	
180		⊙ 47	
351. 30		▽ 100. 30	
251. 00		B 251.	
100. 30			
		25	100
		240	230
		330	175
		310	325
		640	00
		680	120 *ag. Hedge*
			On Woodfield

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